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Popular Science

THE What's New MAGAZINE

New Research on Steel-Belted Radial TIRES Fights the Hazards of Rain-Slick Roads

IOW WELL DOES THE VANKEL WEAR?
Ve Tear Down Our MAZDA After 8 Months on the Road

S '73 TRAVEL MAP
85 Great Science xhibits You Can Visit

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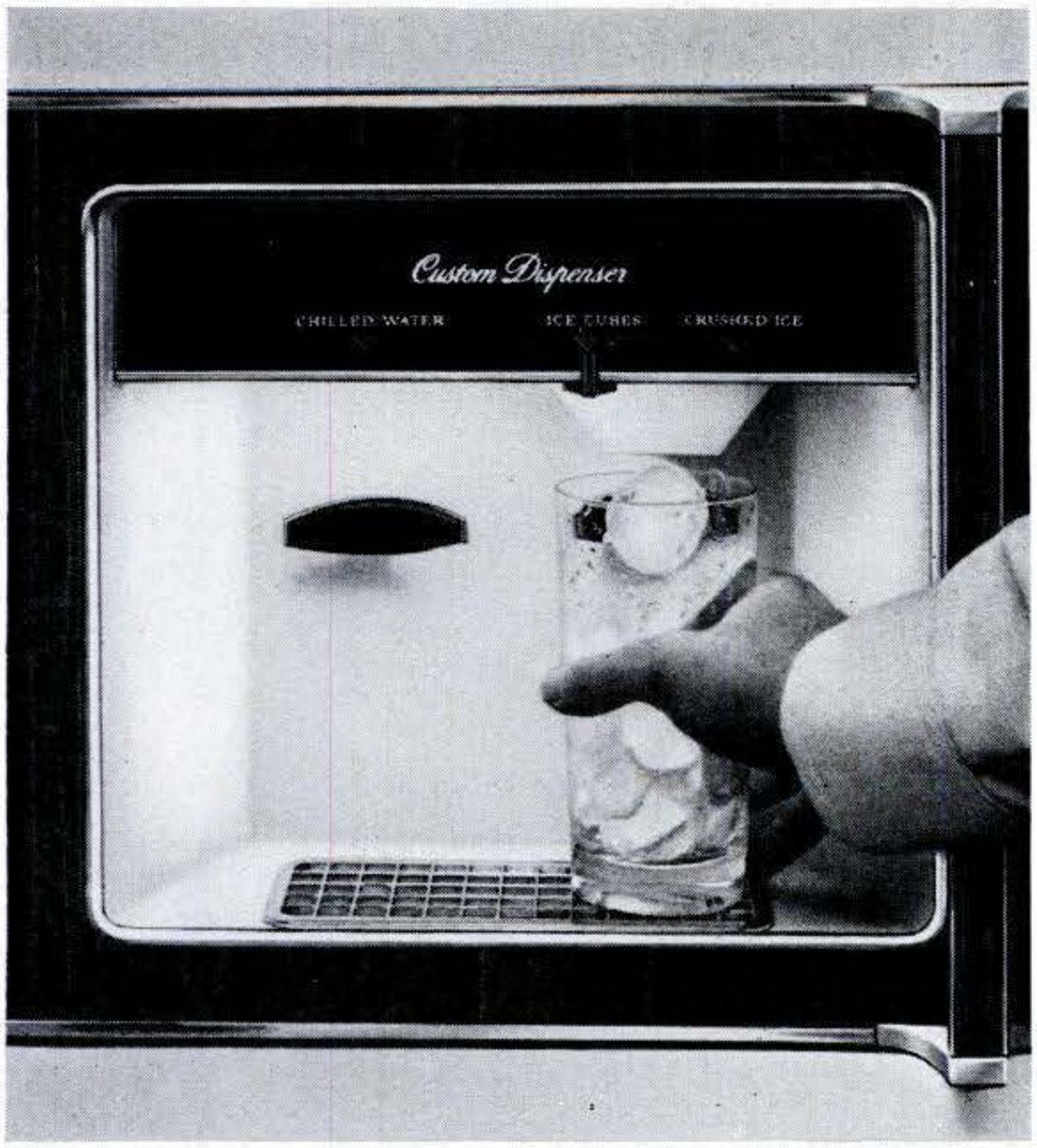
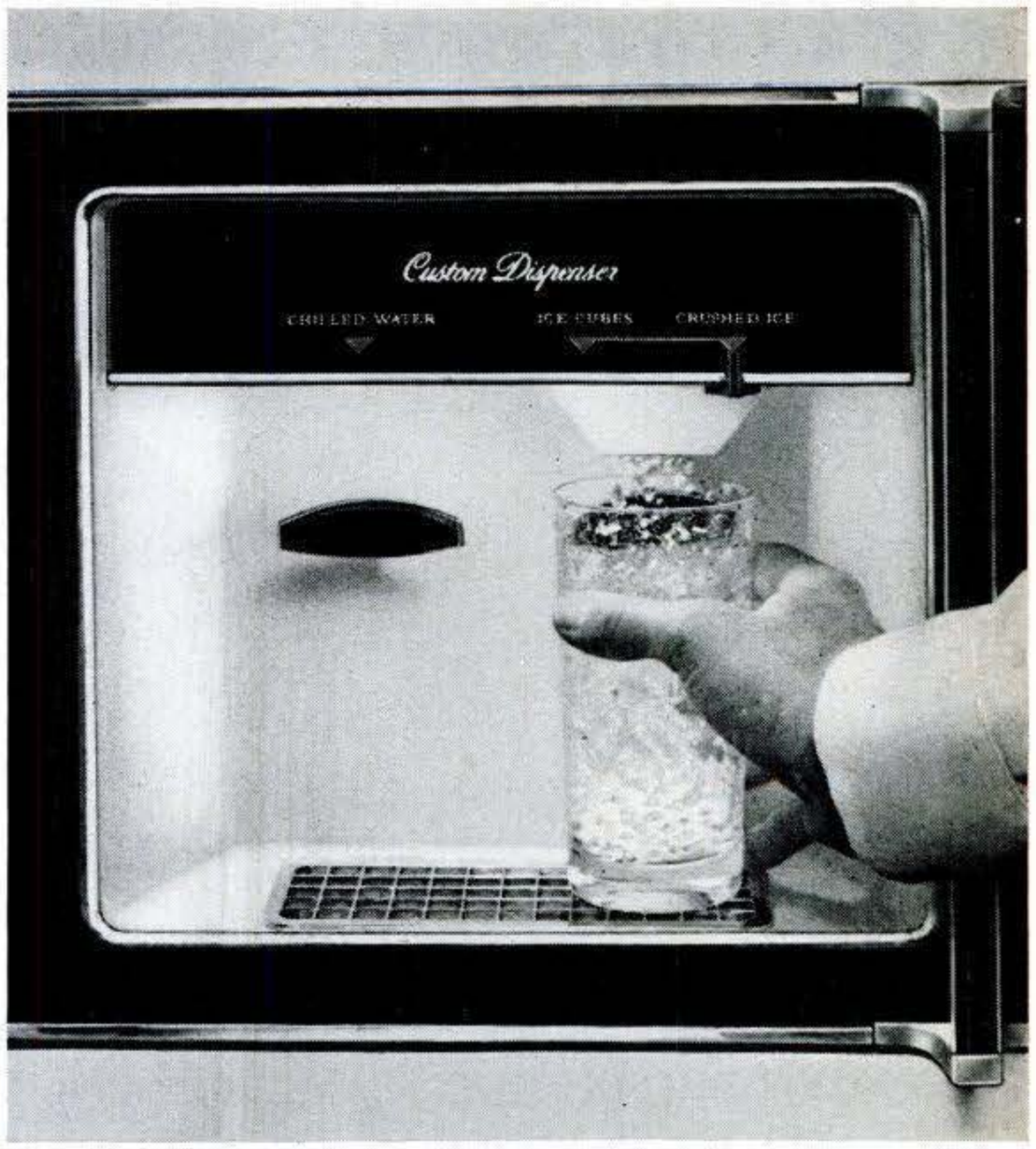
We even crush it for you.





And if that's not enough, we also give you cold water.

Now General Electric offers a refrigerator that does all three —all without opening the door.

With our Custom Dispenser, you just press a cradle on the front of the door and get all the crushed ice you want—a glassful or a whole ice bucketful. And you don't warm up the freezer with a lot of door opening, either.

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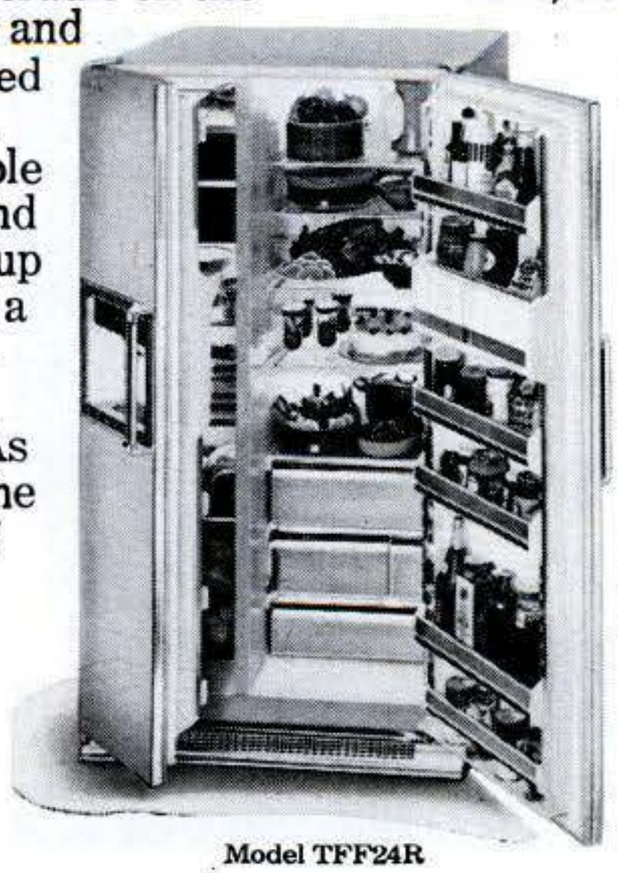
For instant chilled water, press the other cradle. Or if you want, use both at once.



Model TFF24R

Our Custom Dispenser refrigerators also feature tempered glass shelves that adjust to your storage needs; and since they're solid, spills never drip through. (Wiping up is a snap.)

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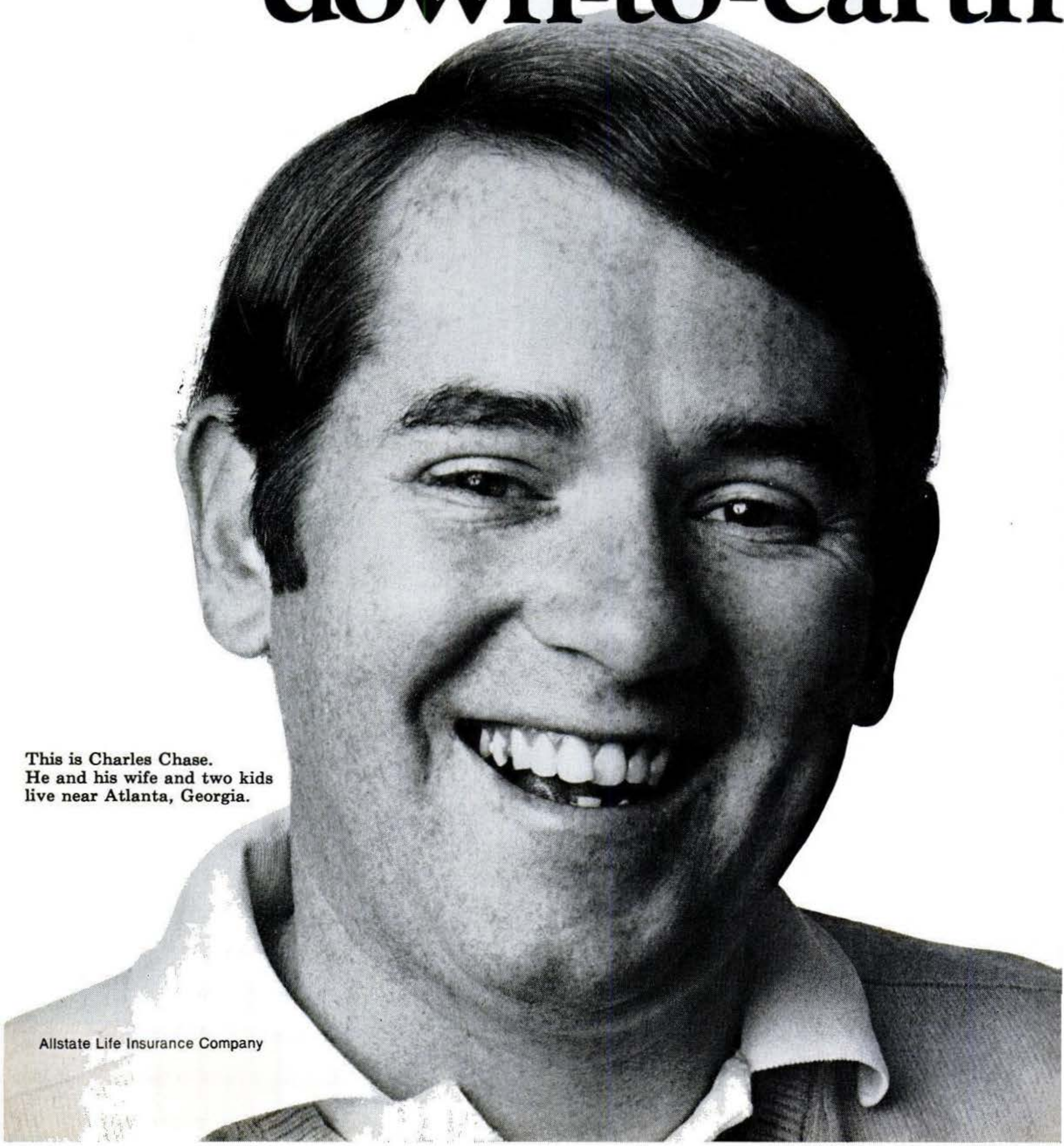

This is Charles Chase.
He and his wife and two kids
live near Atlanta, Georgia.

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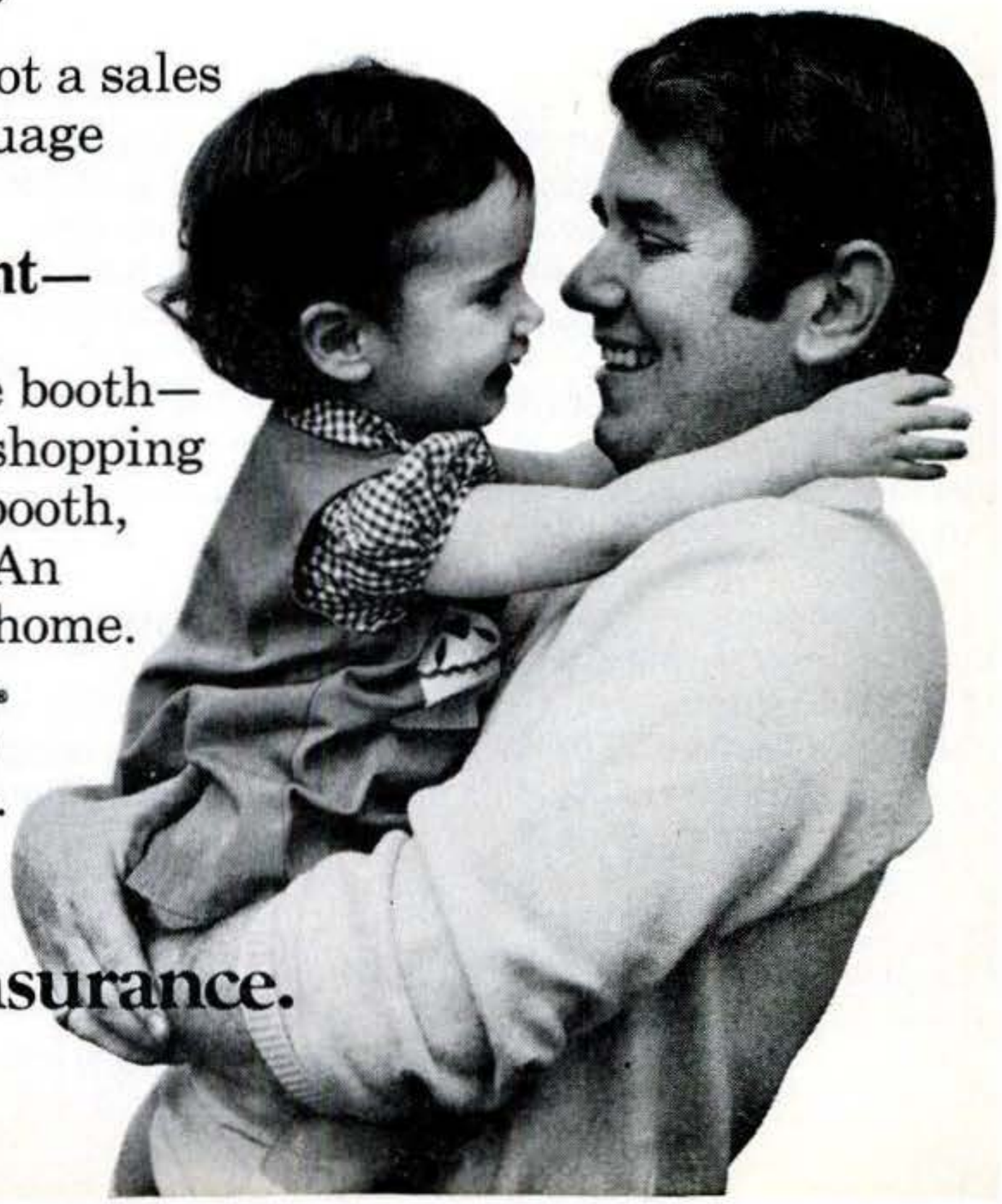

The young man's life insurance.

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How to Tune More Speed into Your 10-Speed Bike

New KROV Engine Boosts Hope for Steam Cars

Wankel Outboards Hit the Racing Circuit

How Electronics Is Revolutionizing Photography

Build a Skylight Workshop in Your Backyard

MAY 1973

Vol. 202, No. 5

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THE What's New MAGAZINE™

MAY 1973 Founded in 1872/Vol. 202 No. 5

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18 Months and 30,000 Miles on a Wankel PAGE 84
We tear down our Mazda RX2, find gears like new, seals good for another 60,000 miles, emission controls in reasonably good condition.

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COVER PHOTO BY JOE FARKAS

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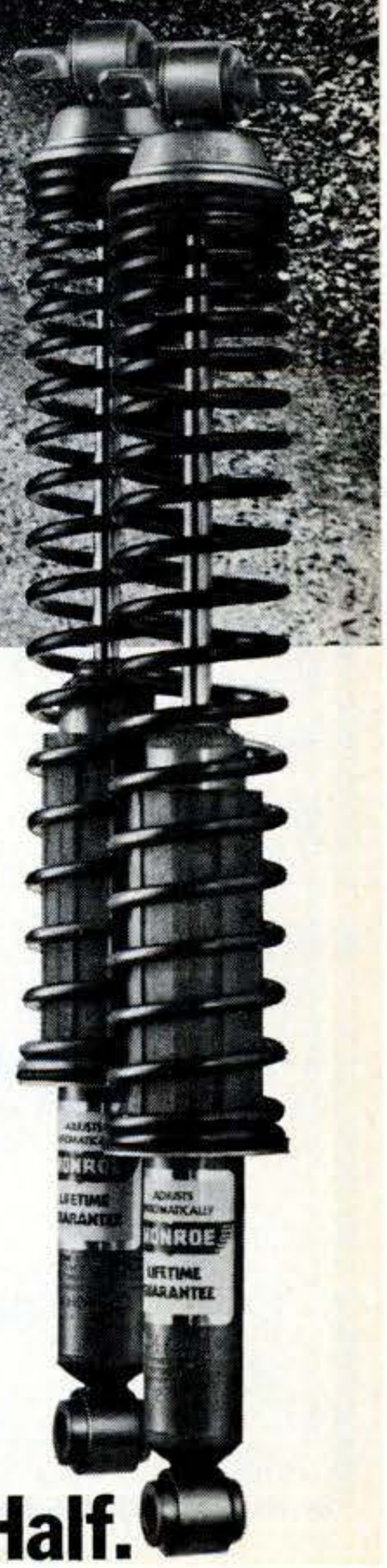

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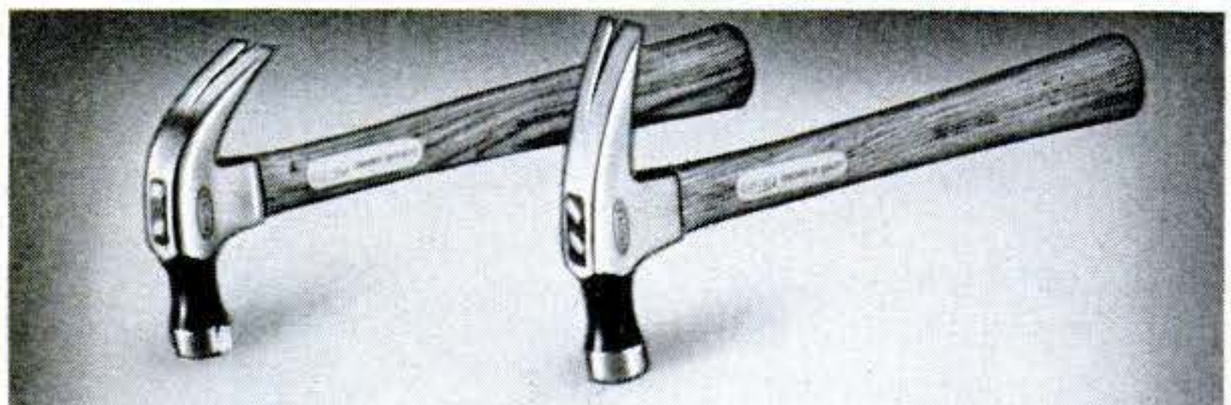

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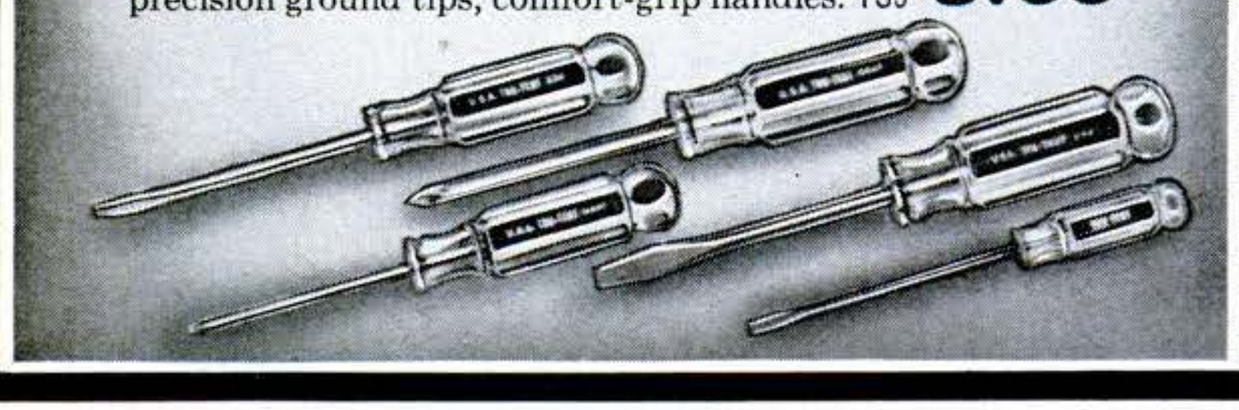

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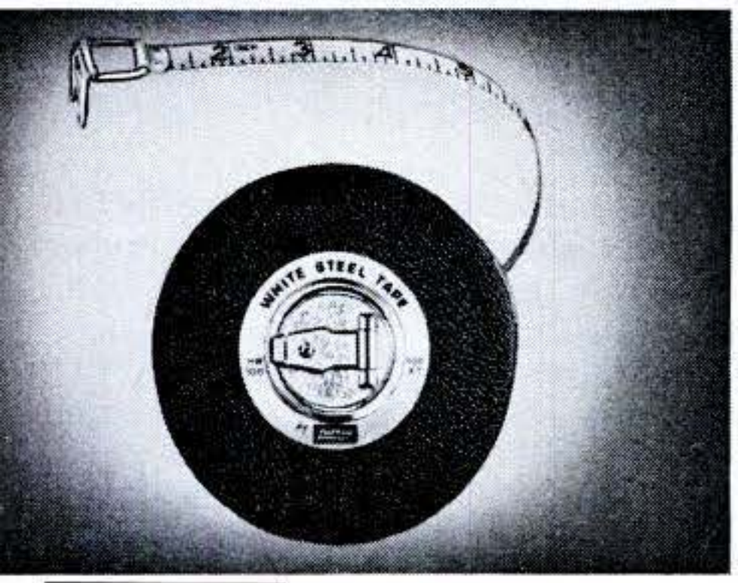

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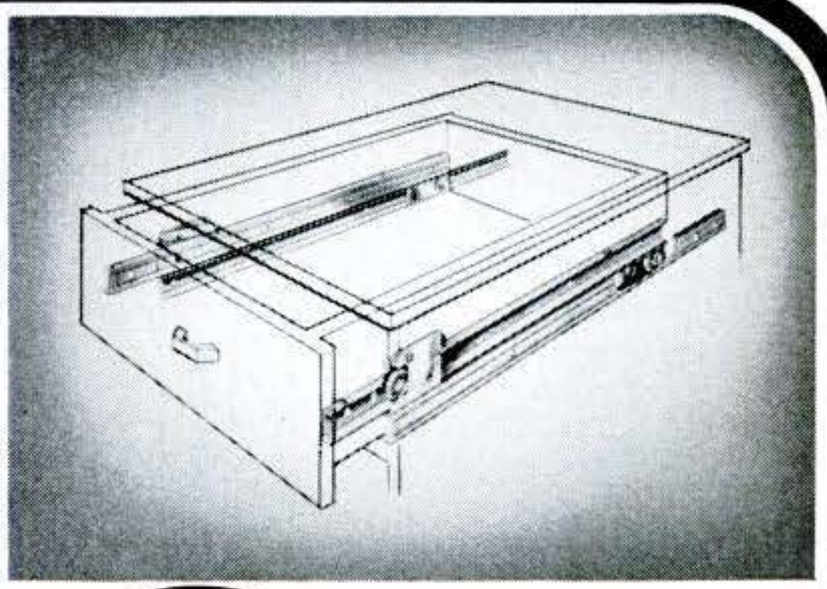

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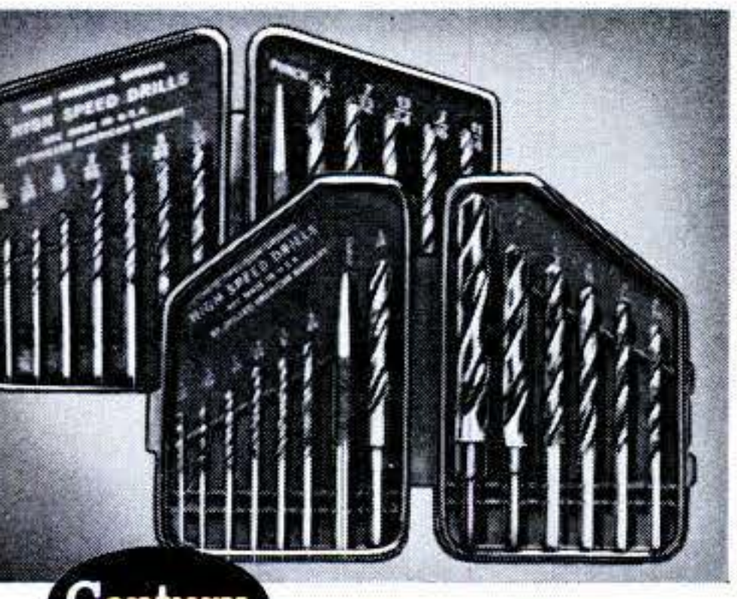

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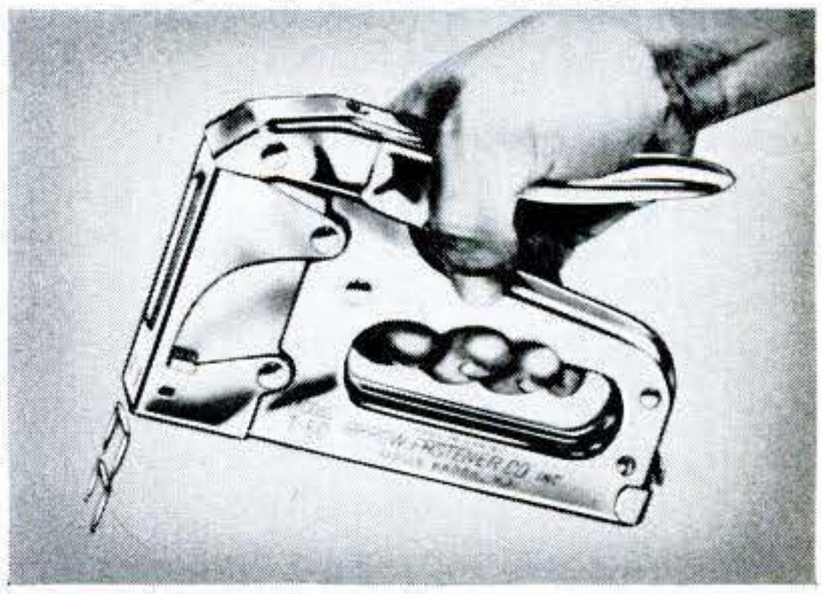

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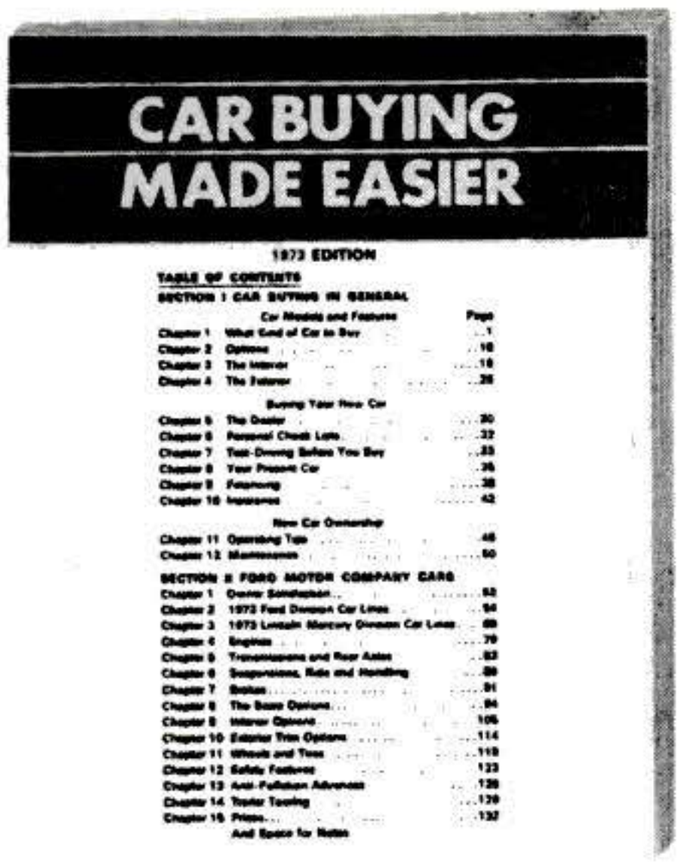

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Seat-belt law protects other guy

Re Carl Replogle's letter in "PS Readers Talk Back" [Mar.]: Since it is legal for people to commit fractional suicide by smoking and fractional murder by making other people breathe their smoke, I suppose it is not surprising for people to choose not to protect themselves by using seat belts. If Mr. Replogle wants to run the risk of serious injury and death, it is his right under the present law. However, I don't think it is right for him and others like him to choose to do this and then expect those of us who do protect ourselves to pick up the tab when they have huge medical expenses that might have been avoided by use of belts. Insurance companies should discount premiums in the proportion to the amount of protection a person uses.

B. A. MICHAELIS, Fredericktown, Mo.

. . . I suppose that Carl Replogle has earned and placed in trust sufficient money to pay the cost of emergency and intensive-care facilities for his maintenance for an indefinite number of years of total disability. Insurance won't do, of course, since the payment for avoidable injuries has a clear impact on the property of others.

CHAS. ORME, Colorado Springs, Colo.

Diesel power, anyone?

I was happy to see in "View Down the Road" [Mar.] that the Environmental Protection Agency is finally encouraging the use of diesel power in automobiles. Some of us already knew the advantages five years ago. I have a Mercedes diesel.

I think Ford and GM have missed the boat on this one. I get 31 mpg on my diesel-powered vehicle (diesel's cheaper fuel, too), so who needs a Wankel or Stirling engine?

DON WOIT, Toms River, N.J.

Credit to the architect

We agree that the "Switch-Hitting Stadium" [Feb.] is a unique structure designed for the pleasure of viewing many sports. We believe it will help to change architects' thinking about future sports arenas, since through its versatility, it will ultimately prove to be less expensive than today's average facility.

By the way, since we did design the stadium, it is unfortunate that the creative source is not mentioned anywhere.

HAL ILLINGWORTH, Charles Luckman Assoc., Los Angeles

Calculator roundup a hit

Congratulations on John Free's "PS Buyer's Guide to Under-$100 Electronic Calculators" [Mar.]. They've been flooding the market at a dizzying pace with great variations in characteristics and price. Your treatment is a neat evaluation and provides ample information for a buyer to consider and it just hasn't been available elsewhere.

JAMES TRAGESSER, Alexandria, Va.

A matter of a few cubic inches

Re your article "Deluxe Compacts: Trendy, Lively, and Practical" [Feb.]: Was the engine in the test Dodge perhaps a 318 rather than the 340 as you stated?

BRIAN WALLACE, Alatamont, N.Y.

Yes, it was.

Successful headboard

Just in case any of your readers are afraid to tackle the projects in your magazine, I am enclosing a

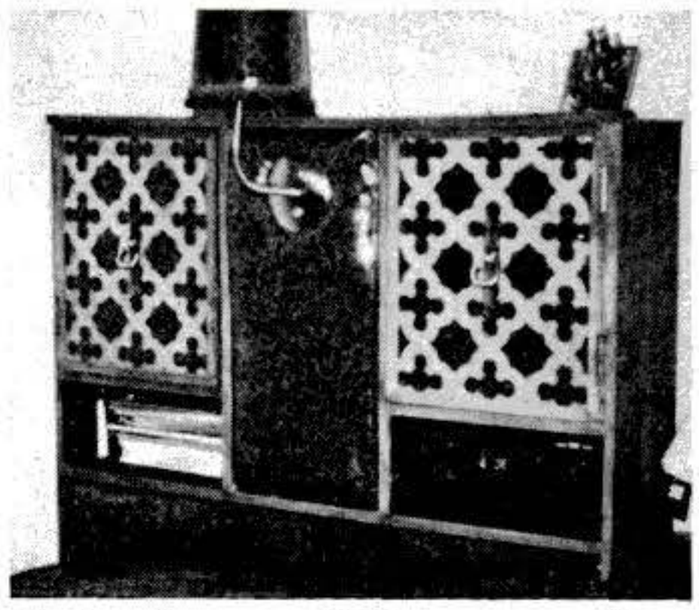

photo of one which my son Don, 17, made last year ["Headboard for Nightowls," Mar. '71]. We are very proud of the finished project and can vouch for the fact that he had no trouble following your specifications.

W. A. MCMILLAN, Ottawa, Ont.

Revolutionary furnace?

From time to time for over 25 years I have read of revolutionary

Continued

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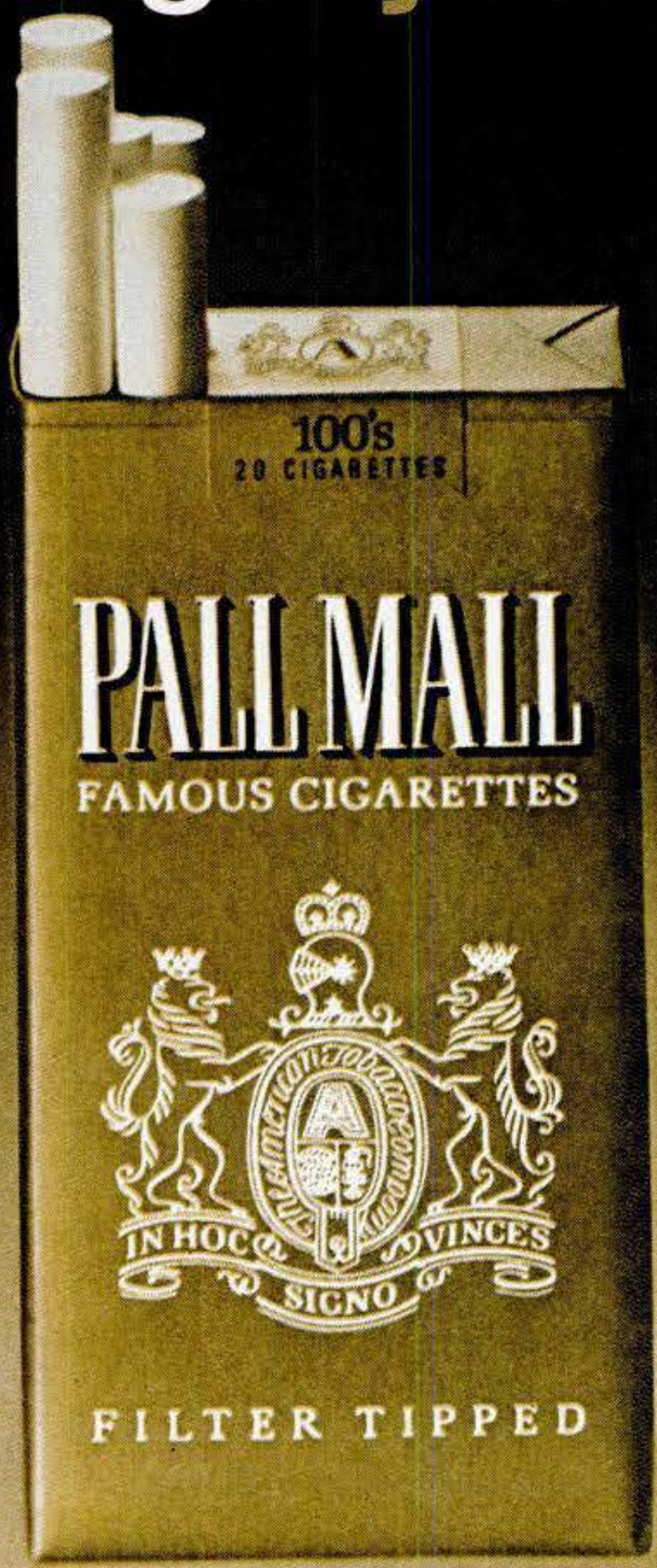
Yes, longer yet milder



PALL MALL
GOLD 100's
Longer length, milder taste

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

20 mg. "tar" 1.4 mg. nicotine av. per cigarette, FTC Report AUGUST '72.

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Try the Wood Fixers from

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America's First Name in Home Fix-up

DURATITE® Wood Dough: the wood fixer. Fills cracks and holes in wood surfaces. Back-fills screw holes to strengthen hinge and hardware attachments. Low shrinkage for faster fills in deep holes. Sands smooth. In natural and 8 wood colors.

DURATITE Surfacing Putty: the surface fixer. A fine-textured wood filler for restoring damaged surfaces. Fills hairline cracks, dents, mars in wood, metal, plastic. Sands smooth.

PANEL-NU™: the wood panel fixer. Spray it on paneling and wipe away dirt, grease, film. Cleans, beautifies, restores surfaces on paneling, cabinets, trim, molding, other finished wood surfaces. Hides scuffs and scratches.

DAP® DAP Inc., Dayton, Ohio 45401
Subsidiary of Plough, Inc.

new furnaces. Thermos-bottle sized, bread-box sized, apple-box sized, etc. To my knowledge, none of these ever went on the market. Now, you report we have "A Furnace the Size of a Soccer Ball" [Feb.]. The unit will cost about $1600 and yield a 10 percent fuel-bill saving.

Let's see how the revolution works out for me: My average

yearly oil bill is $150. Ten percent savings would be $15 a year. Cost of Amana's 80,000 Btu HTM furnace with A/C is $1600. Cost of a standard 80,000 Btu furnace with A/C is $669. Difference in base price is $931. Number of years to break even? 62. Even at double the savings I wouldn't turn any cartwheels. Back to the drawing board, Amana.

J. M. Reilly, Kirkland, Wash.

Filling up with hydrogen

A service station on every corner won't be enough if everyone converts to "Hydrogen: Fuel of the Future?" [Jan.]. Stations will make their own hydrogen with the described on-site packaged electrolytic-hydrogen plant producing only 400 cubic feet hourly. Based on the consumption rate of UCLA's prize-winning car consuming two 480-cubic-foot cylinders for only 50 miles, each service station will be able to serve only 10 such customers per day.

George McConkey Jr.
Titusville, Fla.

You're right. We should have said that one of the "same type" would suit a service station. The maker provides a realistic estimate of 30,000 cubic feet per hour for a service station plant's capacity. This would be roughly equivalent in energy to 50,000 gallons of gas monthly. Floor space of about 1200 square feet (say 30 by 40 feet) should suffice for this hydrogen plant.

More on microwave ovens

"The Facts About Microwave Ovens" [Feb.] was very interesting, but I still don't understand why my dad, who has a pacemaker implanted, is always warned away from them. Can you explain?

Marie Gardener, Vergennes, Vt.

Ovens whose leakage exceeds federal standards may interfere with the operation of demand pacemakers, like those that sense the heartbeat to operate. So can other radiation-emitting devices, such as radar.

. . . Why are the interiors of microwave ovens not in the shape of an ellipse? Wouldn't that eliminate the need for a stirrer (along with its motor) and distribute the microwaves perfectly, provided the magnetron tube was set at the focus of one of the parabolas?

John Hamilton
Long Beach, Calif.

Good question. Reportedly, there is a circular model now made in Sweden.

. . . Every ad says that we can bake a potato in four minutes. Who wants to live on baked potatoes? We own a microwave oven, a good one, but find that anything in the bread or cake family comes out rubbery and impossible to eat. Even the warming process is impossible. You can't cook eggs, and I've had to devise special equipment to cook bacon so the fat will drain. So breakfast is out. Steak is impossible. It isn't even covered in the beautiful cookbook that came with the unit. For the above reasons it takes an artist of great skill to use the oven.

Cameron Fair, Riverdale, Md.

Bread, as we mentioned in the article, is difficult to bake, but not to warm if careful attention is paid to time–one thing that microwave users often have difficulty educating themselves to. The new metalized cookware lets you cook eggs. Large amounts of bacon do create too much grease, but up to about five slices do not. Steak is superb with the new browning cookware. Finally, ordering the cookbook we suggested would solve your recipe problem.

A pipe stand for tune-ups

"A Pair of Pipe Tables" [Feb.] reminded me of an auto tune-up stand I built out of plastic pipe a while back. I made the top of the stand the same height as my radial-arm saw table, so that it serves double duty as a support for a long, cumbersome board being sawed.

Here's a photo of it as a tune-up stand.

J. M. Randall, Atlanta, Ga.

Want to get something off your chest? Write "Readers Talk Back," Popular Science, 355 Lexington Ave., New York, N.Y. 10017

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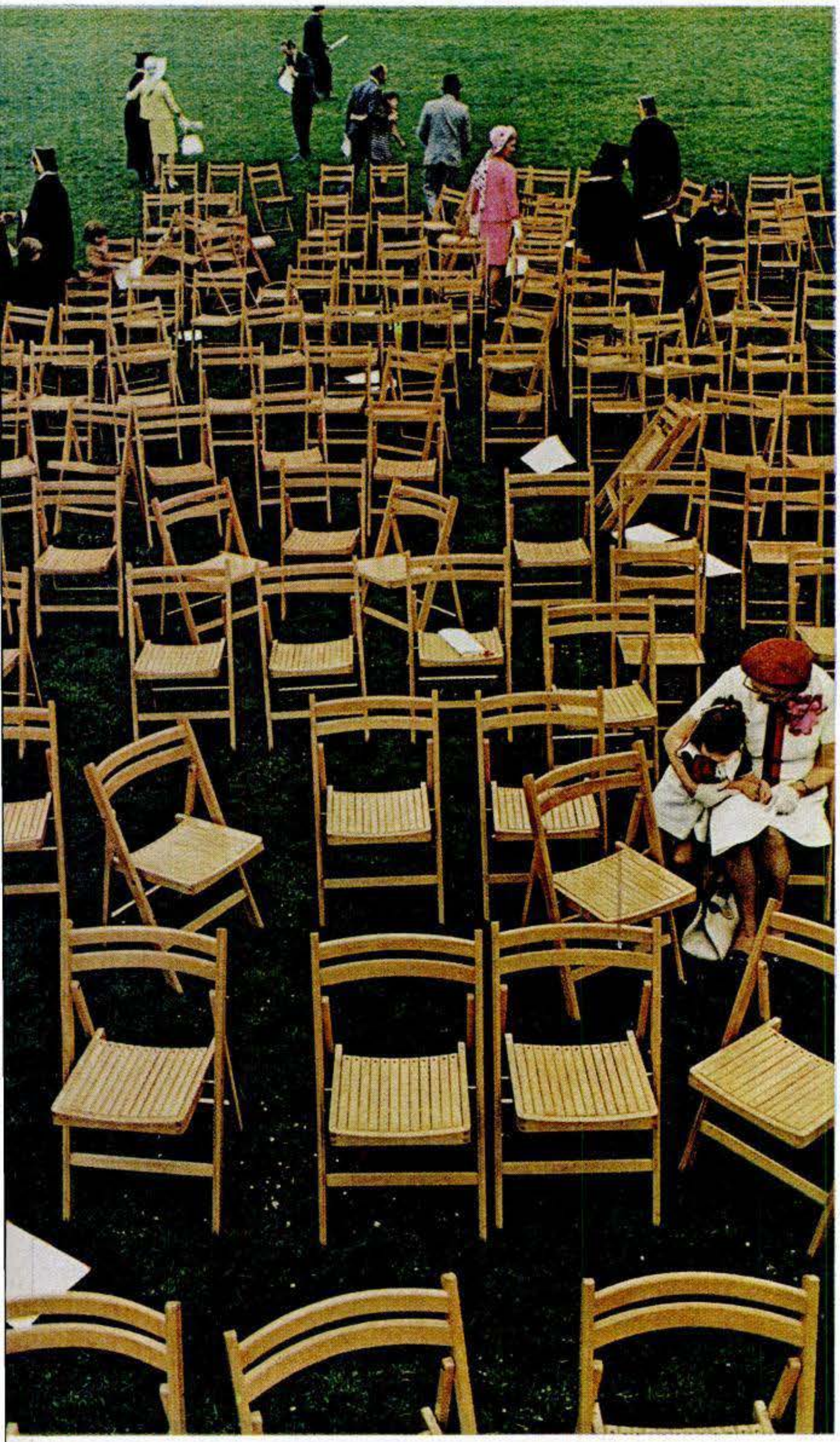
What are you doing after school?

Some of your friends will be going away to college. Others to jobs. What are your plans? If you haven't made any yet, consider a job with today's Army.



A job that starts you at $307.20 a month before deductions. With free meals, housing, medical and dental care, and 30 days paid vacation each year.

A job we'll teach you to do, in one of over 200 job-training courses.

A job that can become a career in the Army, or out.

A job that gives you a chance to travel. Make new friends. Meet people. Mature.

With our Delayed Entry Option, you can sign up today and report within the next six months.

Talk it over with your Army Representative, or write Army Opportunities, P.O. Box 5510J, Philadelphia, PA 19143.

Today's Army wants to join you.

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The View Down the Road

. . . news and comments on cars and driving

By JAN P. NORBYE / *PS Automotive Editor*

Tires on my mind

In researching our wet-traction article (page 72), Jim Dunne and I learned many more facts about tires than we could include. We spent two days in Akron, interviewing engineers and executives. We talked to chassis engineers in Detroit and experts of Pirelli and Michelin in N.Y. And we discussed tire testing with the DoT. We'll be writing some follow-up stories on tires later on. But there's some information I want to share with you right now.

The hazards of rain-slick roads

You may not realize how much danger there is when rain starts falling. The first raindrops mix with oil and road dust and grit to form a very slippery layer right on the surface. More rain washes some of this away. So pay extra attention the first few minutes of a shower. As for wet-weather accident statistics, we found two impressive items:

The state of Virginia reported that 91.8 percent of skidding accidents occurred on slippery roads, even though the roads were dry for 75-80 percent of the study period.

On Route 52 bypass at Lafayette, Ind., there were 29 accidents per million vehicles using the road when wet, against only 1.4 accidents in the dry. These results are conclusive.

Use free air and save money

You can save a bundle if you put the air inside your tires. Government and industry experts believe tire users lose over $250 million a year in wasted tread wear because of underinflation. Few people put in too much air. And obviously, air never leaks in, it always leaks out.

Dangerously low air pressures were discovered in more than half the cars surveyed by Kelly-Springfield in the Cumberland, Md., area. Most of the cars—exactly 57.5 percent—had tires inflated substantially below the recommended pressures. Only 4.4 percent had overinflated tires; 39.1 percent came within acceptable limits. "Underinflation from four to 12 psi cuts tire life from 10 to 40 percent," says a study sponsored by the U.S. Department of Commerce.

Worn tires are failure-prone

Tire-labeling standards, due to go into effect soon, and federal requirements for design and manufacture of tires, in effect since 1969, focus on new tires. There is little control over worn-out and abused tires already on the road. Firestone's vice-president for research and development, Clark E. Stair, calls for better enforcement of minimum tread-depth laws, and for efforts to get car owners to perform their share in assuring safe vehicle operation. He's right, you know.

Wider tires on your old car?

Many readers have asked for information on rim-width/tire-size compatibility. The following rules apply to 13-, 14-, and 15-inch wheels. If you want 70-series radials, you'll get best results with seven-inch rims. But you can fit up to ER70 tires on 5½-inch rims. Or up to GR70 tires on six-inch rims, and up to LR70 tires on 6½-inch rims. With narrower wheels, you'll be restricted to 78-series radials. With 4½-inch rims, you can fit up to BR78 tires. With five-inch rims, you can go as high as ER78. For the fullest possible information, you can order your own copy of *Tire Guide* from Bennett Garfield Publications, 2119 Route 110, Farmingdale, N.Y. 11735 ($3).

Hate buzzers—but buckle up!

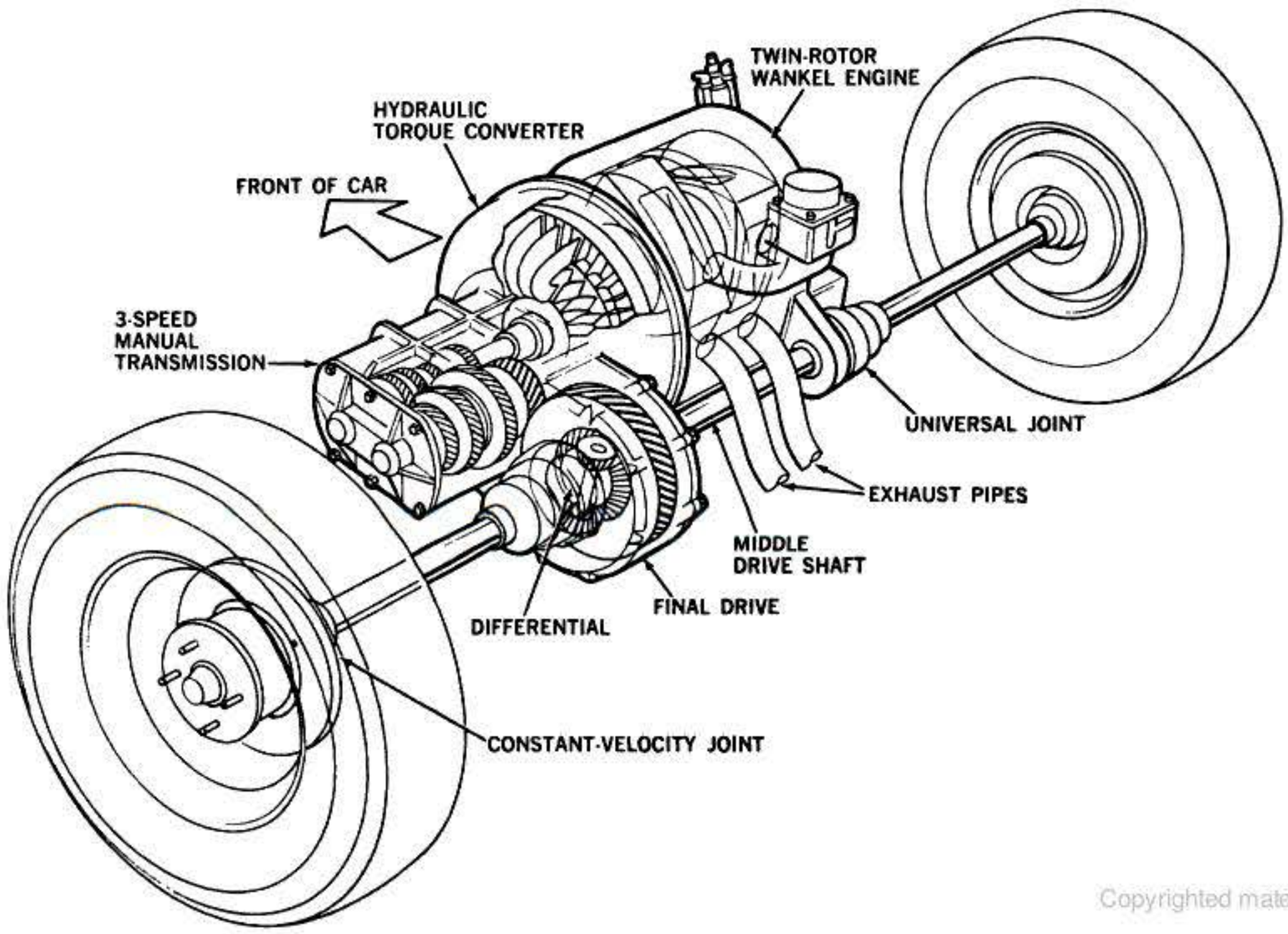
Seat-belt use is growing fast this year, since new cars come equipped with devices that give off a highly disagreeable buzz as soon as you move into Drive—unless your seat belt is fastened.

Two Detroit companies sponsored two independent surveys and came up with almost identical figures for seat-belt usage: 42.0 and 42.6 percent. The studies covered some 7000 cars equipped with buzzers. In cars without buzzers, the usage rate was found to be 15.2 percent in one study, 29 in the other. Next year we'll get the interlock that prevents the engine from starting until you have buckled up. I wonder how you guys are gonna defeat that!

Go: a Wankel-powered Citroën

Production of a twin-rotor model starts next month. The engine will be placed transversely in the nose of the car, driving the front wheels (see drawing below).

The engine, rated at 115-125 hp, is basically the same power unit used in the NSU Ro-80 (with modifications in the cooling systems and carburetion setup). Transmission will be a manual three-speed, but the clutch will be replaced by a hydraulic torque converter. You get two-pedal control but not automatic shifts. The engines will be made by Comotor in Altforweiler (Saar, Germany), a joint subsidiary of Citroën and NSU. The car will be assembled in a hyper-modern plant at Rennes-La Janais in the west of France. Will it be sold in the U.S.? Not in its first year, but possibly in 1974. Yes, steel-belted radials are standard on all Citroëns. PS



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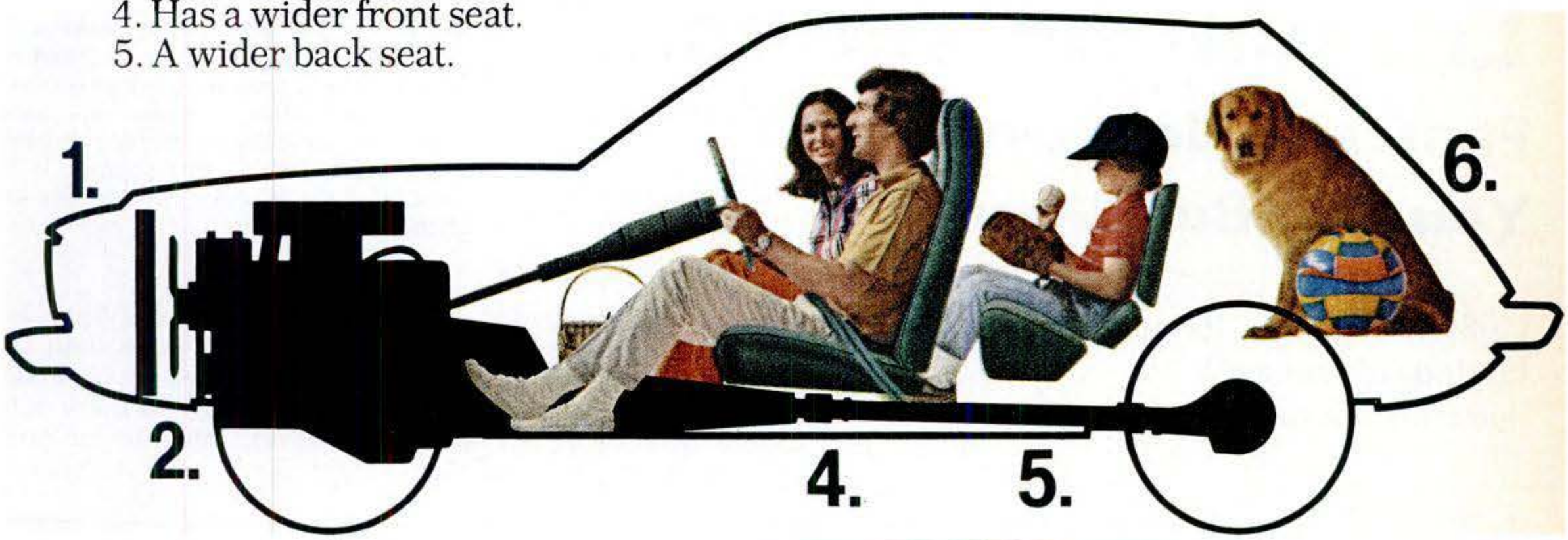
Anatomy of a Gremlin

1. Gremlin is the only little economy car with a standard 6-cylinder engine.
2. Reaches turnpike speed easily.
3. Weighs more than other small cars. And its wheels are set wider apart.
4. Has a wider front seat.
5. A wider back seat.
6. And more headroom in the trunk.

And only American Motors makes this promise: The Buyer Protection Plan backs every '73 car we build. And we'll see that our dealers back that promise.



Buckle up for safety.

AMERICAN MOTORS BUYER PROTECTION PLAN

1. A simple, strong guarantee, just 101 words!
When you buy a new 1973 car from an American Motors dealer, American Motors Corporation guarantees to you that, except for tires, it will pay for the repair or replacement of any part it supplies that is defective in material or workmanship. This guarantee is good for 12 months from the date the car is first used or 12,000 miles, whichever comes first. All we require is that the car be properly maintained and cared for under normal use and service in the fifty United States or Canada, and that guaranteed repairs or replacement be made by an American Motors dealer.

2. A free loaner car from almost every one of our dealers if guaranteed repairs take overnight.

3. Special Trip Interruption Protection.

4. And a toll free hot line to AMC Headquarters.

AMC Gremlin

We back them better because we build them better.

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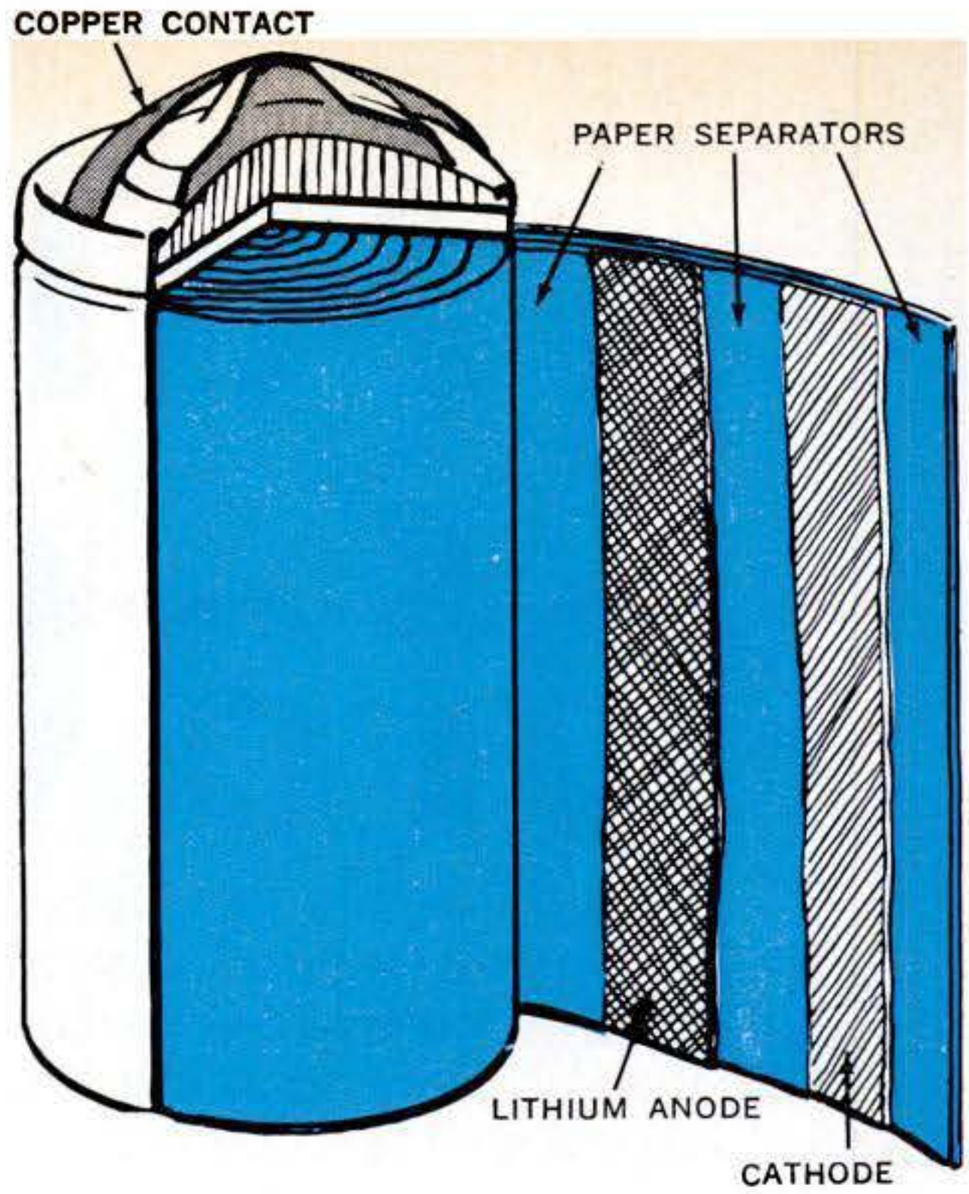
Only outward difference between the new lithium batteries and conventional dry cells is flat copper contact on top of batteries. It will soon be replaced by conventional nipple contact.



Materials and wraparound construction of LithiCell differ from conventional primary batteries. Operating principle is the same. The cathode reduces the anode through an ionically conducting solution, producing electricity. The solution in the LithiCell is put in under two atmospheres of pressure.

Lithium Batteries...

Fantastic New Dry Cells You Can Buy Now

Lighter, stronger, longer lasting—tomorrow's batteries are here today

By RAY HILL
PHOTOS BY ORLANDO GUERRA

The LithiCell?

It's a lithium battery. One of the biggest breakthroughs in battery technology since Volta developed the first operating battery in 1800. In primary (nonrechargeable) dry cell sources it marks the dawn of a new era.

What's so different about it?

- A 10-year shelf life. That's two to five times longer than the shelf life of conventional dry cells.
- Improved low-temperature performance. At minus 40 degrees Fahrenheit the LithiCell performs at 60 percent of its capacity. Conventional carbon-zinc, alkaline, and mercury cells don't work at all at minus 40. In fact, conventional battery performance deteriorates drastically at 20 degrees F, a temperature at which the lithium cell is still functioning at 96 percent of its total capacity.
- Reduced weight. An alkaline D cell, for instance, weighs 4½ ounces. A lithium D cell weighs only three ounces.
- Higher voltage. The lithium cell produces three volts, compared to the 1.5 volts of conventional batteries.
- Higher energy density. A lithium cell packs more than twice as much energy into each ounce as any other cell. This means a lithium battery will last much longer than conventional cells. For example, a tape recorder powered by ordinary alkaline batteries will operate for about

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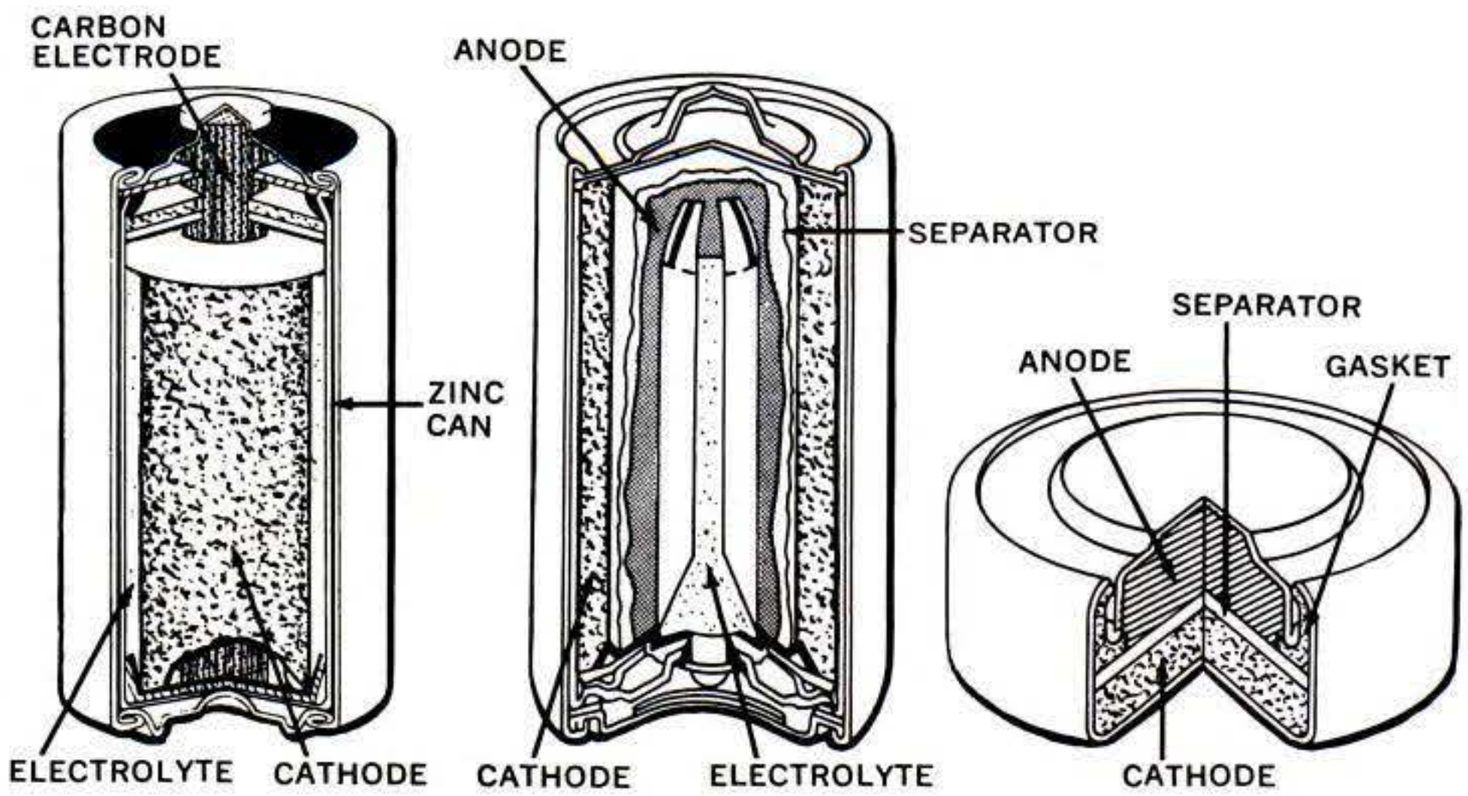
Construction of conventional dry cells



Carbon-zinc cell has a zinc anode, a manganese-dioxide cathode, and an electrolyte solution of ammonium chloride and zinc chloride dissolved in water. It works well under low drain conditions, such as in flashlights and toys.

Alkaline cell differs from carbon-zinc cell mainly in its highly alkaline (potassium hydroxide) electrolyte. It works under continuous high-drain conditions where a carbon-zinc battery can't, as in shavers, tape recorders, small TVs.

Mercury cell has a longer shelf life and more power per unit volume than the carbon-zinc or alkaline cells at left. But it falls far short of matching performance with the high-energy lithium cell. Mercury cells are often used in cameras.

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When the funny stories you share are about your travels and not about your travel trailer, it was probably built with Starcraftsmanship.

There's something mechanical about the stories most people tell about their travel trailers.

Someone's heating system only worked on hot summer nights.

Somebody couldn't swing their legs out of bed without hitting the kitchen table. Very funny.

At Starcraft we think jokes like that are on the companies who build the travel trailers and we don't care to be one of them.

That's why we build our travel trailers with Starcraftsmanship.

Starcraftsmanship is our standard of excellence. Coming up to that standard has meant developing the leading research and design center in the industry—a center that can create trailers so complementary to your traveling lifestyle you aren't even aware of them.

The Wander-Star is our biggest and most luxurious model. It's designed with enough space to carry a household of people and things all over the country. Without crowding out anybody's sense of humor.

If you want, you can get a model that has a forced air heating system that works like central heating.

And because some people think a shower means a light rain, you can also choose a model that has a bathroom complete with a tub.

The Wander-Star has a lot of attractive features. But more than the features and the quality materials we build them out of, Starcraft puts value in craftsmanship.

When we install carpeting, we don't come up an inch short under the bed.

When we put latches on the doors we open and shut the doors a couple of times to see them latch.

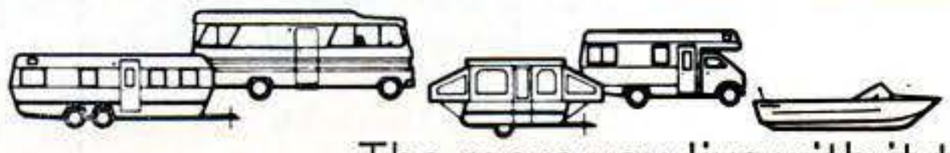
When we install a clock, it ticks. We're so serious about Starcraftsmanship it's almost funny.

But it's why we can afford to give the warranty on materials and workmanship that we do.

And why people who own Wander-Stars can tell you lots of funny things about their travels. But not lots of stories about their trailers.

We'd rather you laughed at our attitude and appreciated our travel trailers.

Write to us for more information on our full line of Wander-Star Travel Trailers. Dept. **F27-5**
Starcraft Company, Goshen, Indiana 46526



STARCRAFT

The more you live with it, the more you appreciate it.

A Bangor Punta Company

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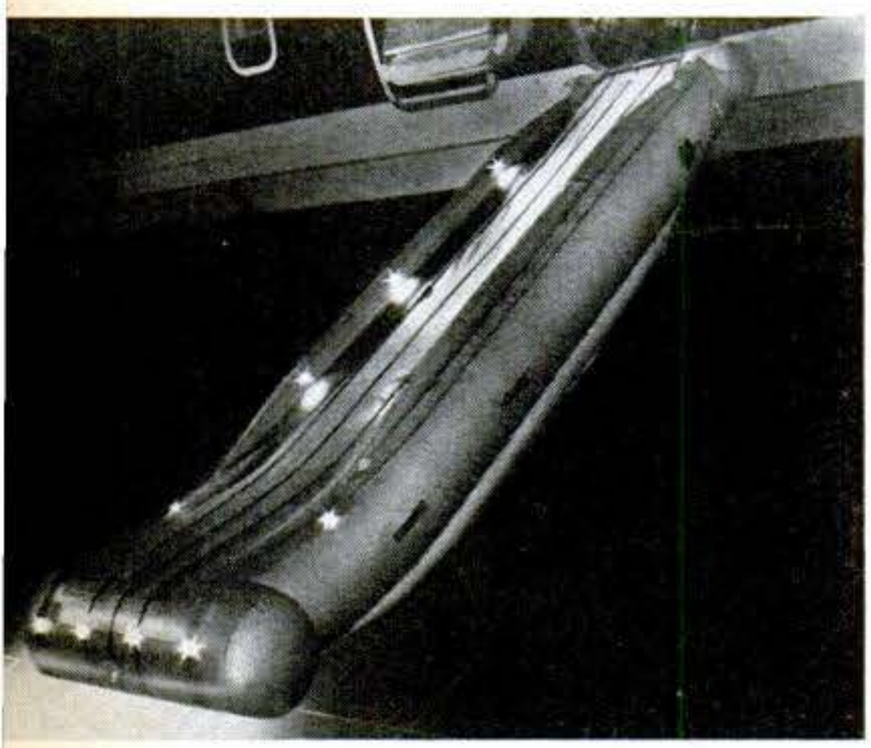
Powered by lithium cells, emergency locator transmitter for downed pilots will operate even at 40 below zero. Powered by mercury cells before, it was unable to operate at 20 above.



Operating independently of aircraft's electrical system, the 12 halogen lamps on escape slide are lighted by LithiCells, due to their dependability, longevity in adverse climatic conditions.

five hours in continuous use. That same tape recorder powered by only half as many lithium batteries will operate continuously for about nine hours.

A 10-year puzzle. The idea of a lithium-powered battery isn't new. For the past 10 years several companies have been doing experimental work with lithium. The big problem was packaging the lithium so it wouldn't destroy itself chemically. When exposed to the air and its accompanying moisture, lithium deteriorates rapidly.

The problem was solved by pumping in a nonaqueous electrolyte (consisting partly of sulphur dioxide) under two atmospheres pressure, then hermetically sealing the battery to prevent outside air from reaching the lithium and damaging it. After an extensive test program, Chromalloy Electronics Div. of Chromalloy American Corp., 3901 N. 29th Ave., Hollywood, Fla., released the LithiCells for sale to the public.

Other companies will soon be on the market with lithium dry cells. Mallory, already selling modified C and D lithium batteries to the military, expects to be offering lithium batteries to the public within a year. Panasonic also expects to be in commercial production soon.

LithiCells are available in four sizes: C, 3/4 C, D, and the 2XRM1, a small special cell for use in rescue and survival equipment. The big drawback right now is their high cost. The 3/4 C cell is $5.90; the C is $7.94; the D is $11.48; and the 2XRM1 special-purpose cell is two dollars. If the batteries are ordered in large quantities, as in an industrial contract, the price drops considerably; 1001 C cells, for instance, are only $4.76 each.

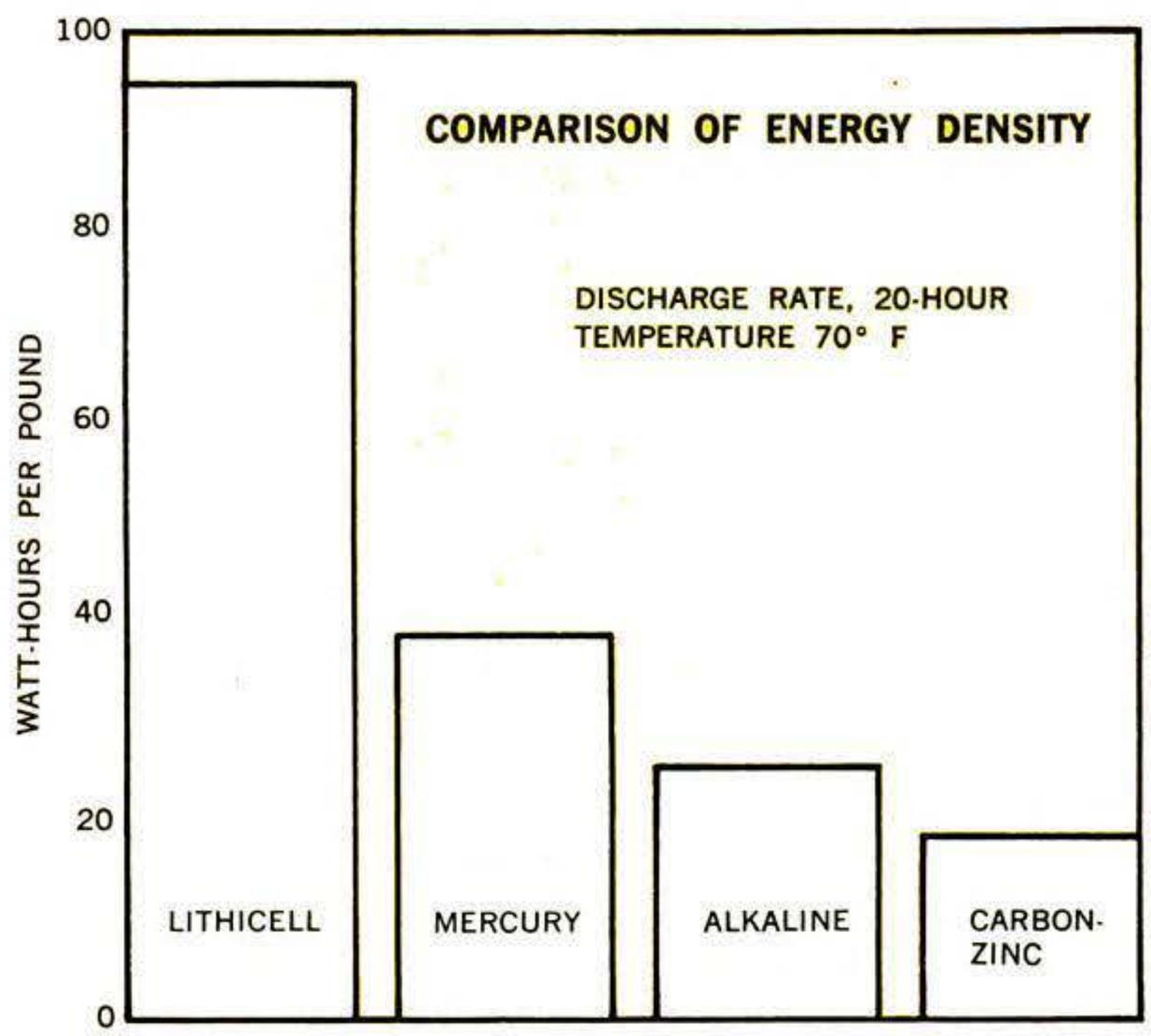
Rescue strobelight used by Navy UDT and SEAL teams is powered by LithiCells, delivers 50 flashes a minute. In continuous operation it will flash for 10 hours. Total weight, including battery, 7 ounces.

Hefty price tags. But they are expected to drop sharply during the next six months as production increases. Eventually, Chromalloy spokesmen predict, LithiCells will become competitive in price with conventional cells.

Right now commercial airlines and the U.S. military are the biggest buyers of LithiCells. They're using them in their emergency equipment where there's a premium on weight and space, and where longevity and reliability (especially at low temperatures) are very important. In this kind of situation, the lithium battery wins hands down, even with its high price.

If you can't wait until prices drop, you can order LithiCells from Chromalloy now. Just remember that it takes only half as many three-volt LithiCells to produce the same voltage as conventional series-connected 1.5 volt batteries.

Recharging lithium. It will be a while before your car battery will be made of lithium. Engineers haven't yet figured out a way to get a lithium battery to hold a charge once it's been recharged. But they're confident this problem will be overcome and that secondary (rechargeable) lithium batteries will become a reality. PS



PRIMARY CELL COMPARISON

	Carbon-Zinc	Alkaline	Mercury	"Li-Cell"
*Shelf-life storage temp. (70°F) (130°F)	1-2 yrs. 1.5 mos.	2-3 yrs. 2 mos.	3-4 yrs. 4 mos.	10 yrs.+ 12 mos.
Low temperature percent of (70°F) capacity +20°F —20°F —40°F	5% 0% 0%	15% 3% 0%	0% 0% 0%	96% 85% 60%
Watt-hrs. per pound	19.5	26	40	95
Watt-hrs. per cubic inch	1.6	2.3	4.4	6.3

*Time in years or months that a cell will provide a minimum of 75% of its initial capacity at room temperature.

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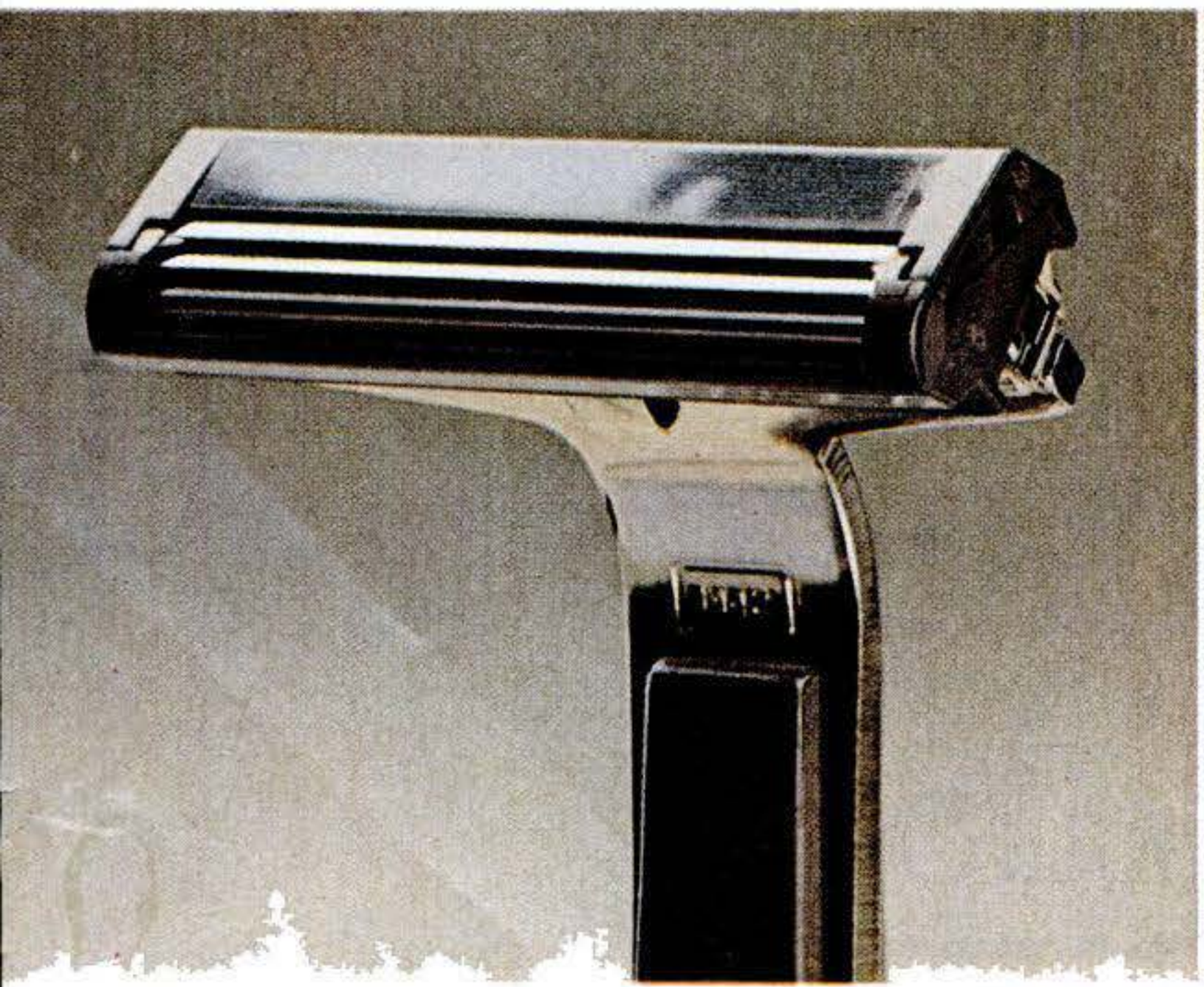
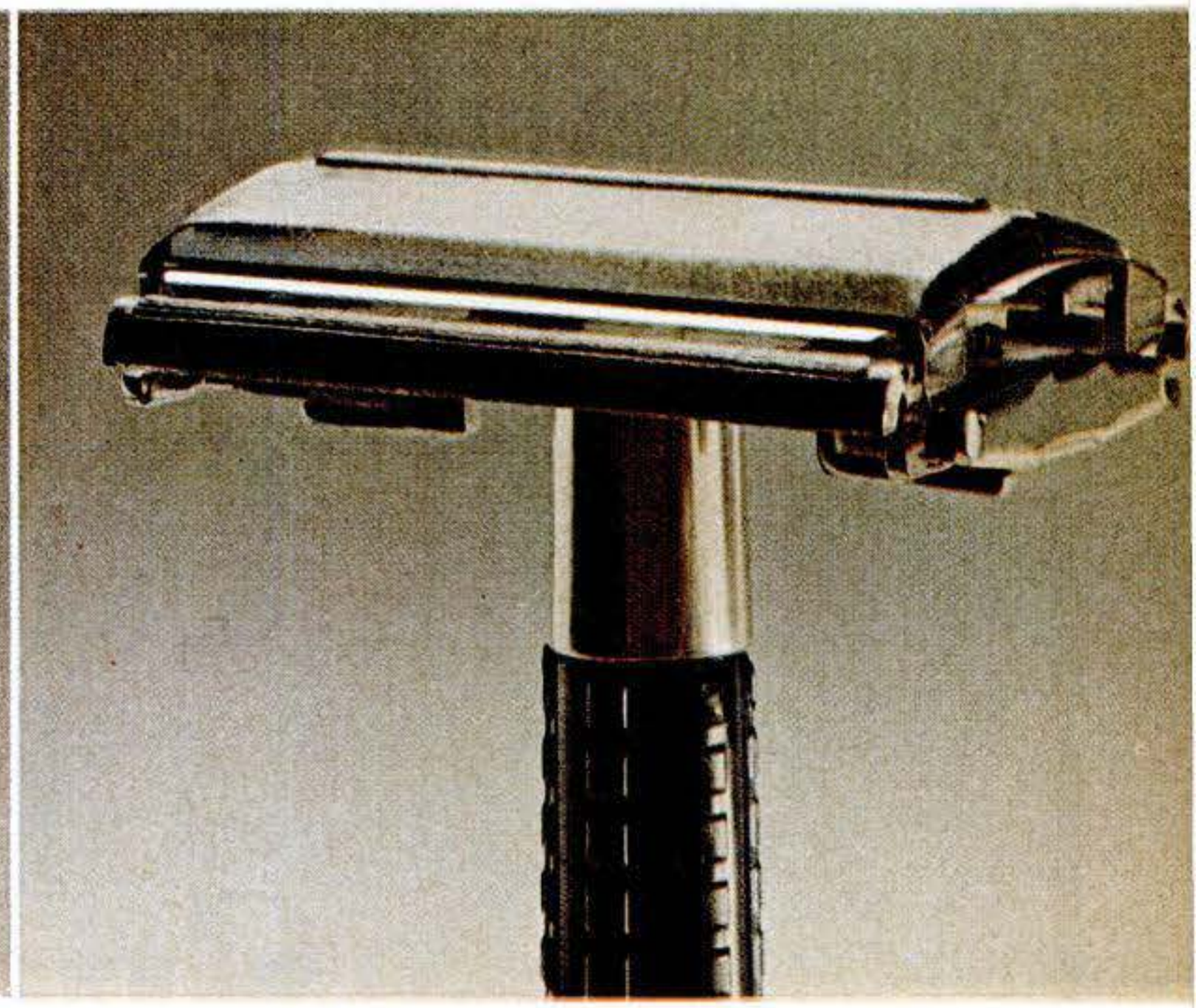
Schick Super II against I.





How double is a double edge razor, really?

There's never more than one edge working for you. While the other one's out there goofing off.

Now compare with the Schick Super II:

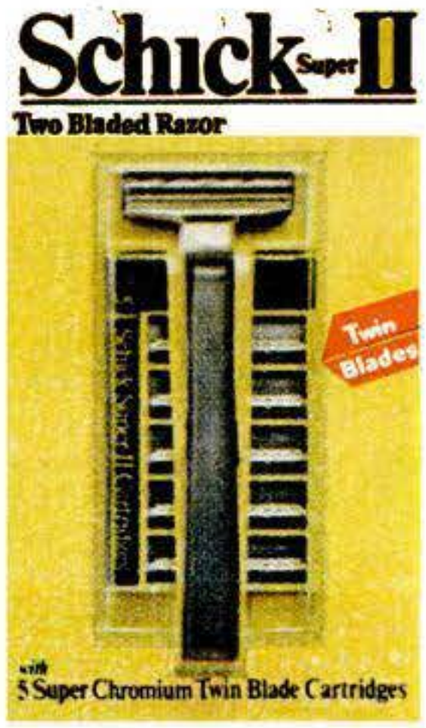
Both edges are on your side. Always working together.

The first edge shaves you close like your double edge now. The second edge shaves you closer.

There's really no comparison.

It's two against one.

Unfair maybe. But that's life.



The Schick Super II. Put both edges on your side.

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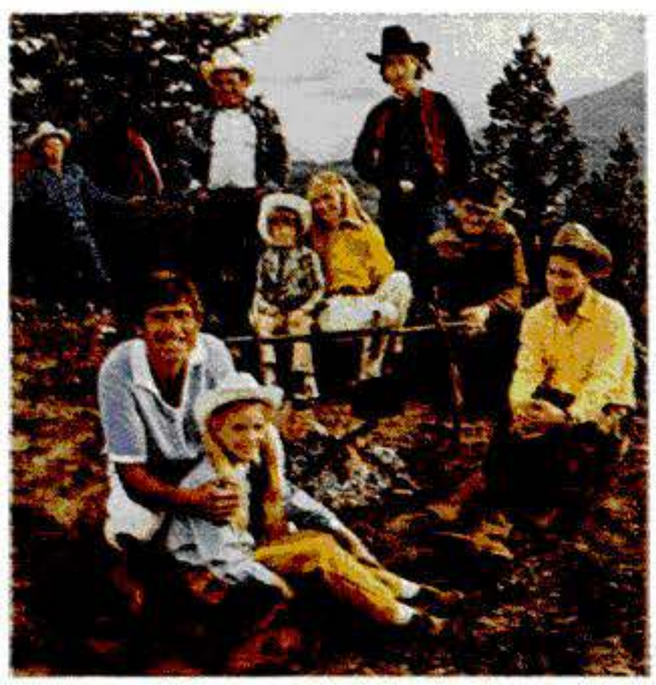
Canada. This Summer.



Summer days last longer in Canada. Our sun rises earlier and sets later than in most parts of the United States. In fact, some places in Canada catch the July sun before 3 a.m. and see it up past 11 in the evening. And such extraordinary days they are—clear, dry and warm. They brown you, relax your ambitions, refresh your spirit and put time back into your own hands. Somebody once said of our long afternoons that they "set you to dreaming again". It's true. You see, a Canadian summer day does more than just take you away from it all. It gives you back yourself.

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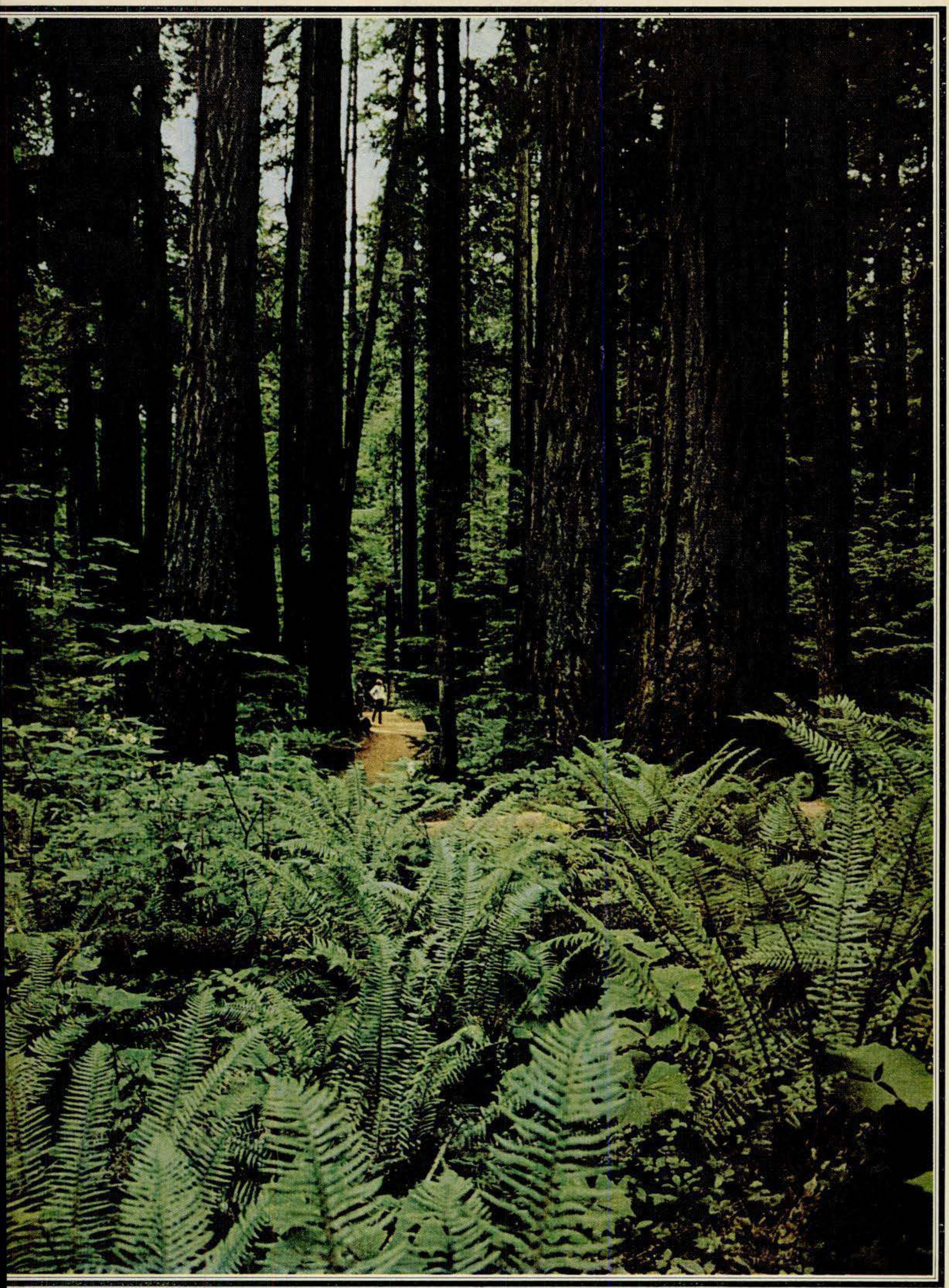

See your travel agent or write to: Canadian Government Travel Bureau, Department E3, Ottawa, Canada. K1A 0H6.

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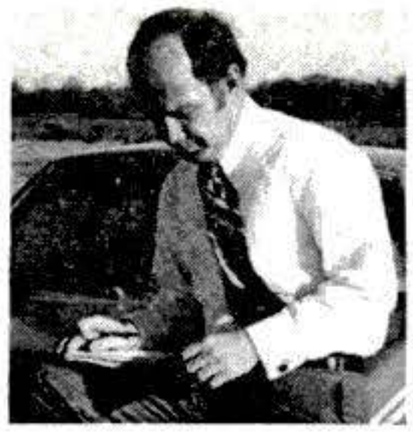

Detroit Report

Behind the scenes in the auto industry

By JIM DUNNE / *PS Detroit Editor*

'74 Mustang returns to original concept

Based on the Pinto's 94-inch wheelbase, next year's Mustang will have the new 2.3-liter four-cylinder engine as standard and a 2.8-liter version of the German-made Capri V6 as an option. Interiors will be sporty, and include low-back bucket seats, a standard tachometer and luxury decor. Options will include a maintenance group, which is comprised of fire extinguisher and tool kit. For the first time a two-passenger model will be offered, but only in the fastback body style. The other four models will be four-passenger capacity and include a Mach I and Grande. Also, for the first time, Ford will offer a power assist with the rack-and-pinion steering gear. Inside trim will have cut-pile carpeting that extends up on the lower portion of the doors, wood-grain textured two-spoke steering wheel and shift-lever knob, and European-type arm rests. Suspension changes are widespread, and in addition to a new standard suspension, a Rally option will also be available. Most striking exterior is the boxy appearance of the notchback roof, and the color-matched urethane front and rear bumpers.

240Z with Wankel—$2400

That's what Pontiac dealers would like to have, but the image is just a dream, something you will never see in the showrooms. More than likely Pontiac dealers will have to settle for an updated version of the Vega. Pontiac factory officials insist they are looking for a number of small models for their dealers to sell, all with a Made-in-U.S.A. tag. Some include a Wankel-powered vehicle. In the end, though, it appears that Pontiac will do the same thing in the U. S. that it does in Canada—share the Vega body with Chevrolet just as it shares all its other bodies.

House calls for your car

A new company, Rov-A-Tune, now will send a mechanic to your house to perform engine tuneups right in your backyard. The tune-up includes replacement of all spark plugs, distributor points, condenser and distributor rotor. For this the owner of a V8 engine pays about $27, for sixes $23. That includes all charges for parts and labor. The serviceman can also replace other defective parts in the automobile not included in the tuneup. Rov-A-Tune is a franchising system set up by American Franchising Systems, Inc., in Southfield, Mich. Does it pay off? Evidently. The company claims that one man and truck can make a minimum of $23,000 a year.

Tire dealers to sell new GM tire

At the same time that GM reports it will market a steel-belted radial "corporate" tire on some 1974 models, it also reveals the same tire will be available through independent tire-dealer outlets as well. It has to be set up this way. A GM car owner who wants a replacement for the tire that comes on his new car can't get it from the car dealer, so he must go to the tire dealer. That means Goodyear, Firestone, Goodrich, General and UniRoyal will sell tires that are identical in construction and appearance except for the tire company brand name embossed on the sidewall. GM also expects that other auto companies will use the same tire on their new cars in coming years, too.

Competitors can buy GMRE

GM officials announced that the company would, if past practices were followed, sell rotary engines to outside companies—including Ford, Chrysler and American Motors—if they want to buy them. While GM is still working out problems of production startup right now, it expects to have the engine in full production within 18 months, and could make it available to outsiders on a limited basis at that time. One company that has always been interested in such a deal is AMC, and it looks as though either Comotor in Europe or GM could supply rotaries for the 1975½ Gremlin. Presently GM sells a wide range of parts to competitors, including transmissions, diesel and gasoline engines, steering systems and air pumps.

Mercury's Cougar gets fat

While Mustang switches to an all-new smaller package for 1974, Cougar will go the other way. The new model will lose a lot of its glamour when it adopts the intermediate body shell of the Montego. Mercury has specific style in store for the car, but there is no way of getting around the identical body lines of Mercury's intermediate two-door model. Cougar will have its own grille, opera windows and specific interior trim, and be merchandised as something akin to the Grand Prix. But that claim will fool no one. Mercury will have to wait until a major styling change in the intermediate line before the Cougar can get distinctive style.

GM planning electronic ignition

GM will offer a high-energy electronic ignition as part of its emission-control package for 1975 and 1976 engines. No contact points or condensers are used, and no change in tension occurs due to wear of rubbing blocks or contact points. Plugs will last 24,000 miles instead of the present 12,000. This is similar to the system Chrysler uses right now. GM's system differs in that it delivers approximately 35,000 volts and allows longer spark duration with a wider—0.60—spark gap. The wider gap promotes burning of very lean or non-uniform mixtures. GM will install the high-energy system on all its 1975 engines, including the rotary.

Vega engine boost

Chevrolet plans to introduce a high-performance Vega engine option for the 1974 model year that features an aluminum instead of iron cylinder head. The aluminum will provide lighter weight and better heat dissipation. At the same time a boost in horsepower is expected. Eventually, Vega will have an electronic fuel-injection system made by Bosch as part of a performance package. Contrary to reports, only this special Vega and certain Opel lines are scheduled for fuel-injection systems at GM during the next two years. The FI is a low pressure system that has the additional advantage of controlling exhaust emissions, and will be standard in the 1975 pollution package.

Cost of clean air

It will cost owners of 1975 GM cars about $50 for parts and labor just to maintain their emission control equipment for the required 50,000 miles, according to a GM study. Costs are mostly for maintenance items like checking heating valves and engine choke, but include replacement of filters, PCV valves, radiator hoses and engine drive belts. It would have cost much more, over twice as much, but for the saving of the electronic ignitions. GM figures that owners will save $52.79 by having electronic ignition. Biggest cost is for engine drive belts, estimated at $33.86, while the smallest expected is 19 cents to "retorque carburetor attaching bolts." PS

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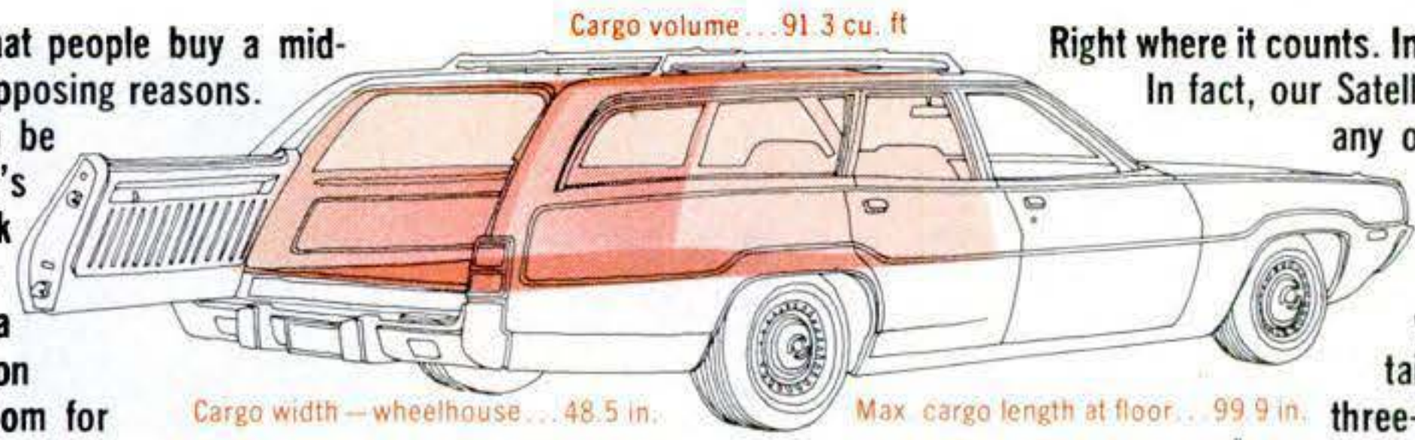
Our Plymouth Satellite Wagon has more cargo room than any mid-size wagon in the country.

We've found that people buy a mid-size wagon for two opposing reasons. One: They want it to be mid-size because it's small and easy to park and maneuver. Two: They want it to be a wagon because a wagon is big with lots of room for cargo and people.



Now we think we've put the best of both worlds together in our Plymouth Satellite wagon. We made it mid-size, with all the advantages of being small. But we also made it big.

Right where it counts. In cargo area.

In fact, our Satellite wagon will carry more cargo than any other mid-size wagon we know of. It beats the competition in cargo length, cargo width and cargo volume. It even carries a 4' x 8' sheet of plywood flat on the rear floor with the tailgate closed. And, of course it has a three-way tailgate to make it easy to load either things or people.

If you're thinking of buying any wagon right now, test drive our Satellite wagon at your Chrysler-Plymouth dealer's. You'll find out why it's so big with so many people.

Mid-size Plymouth Satellite

Extra care in engineering...it makes a difference

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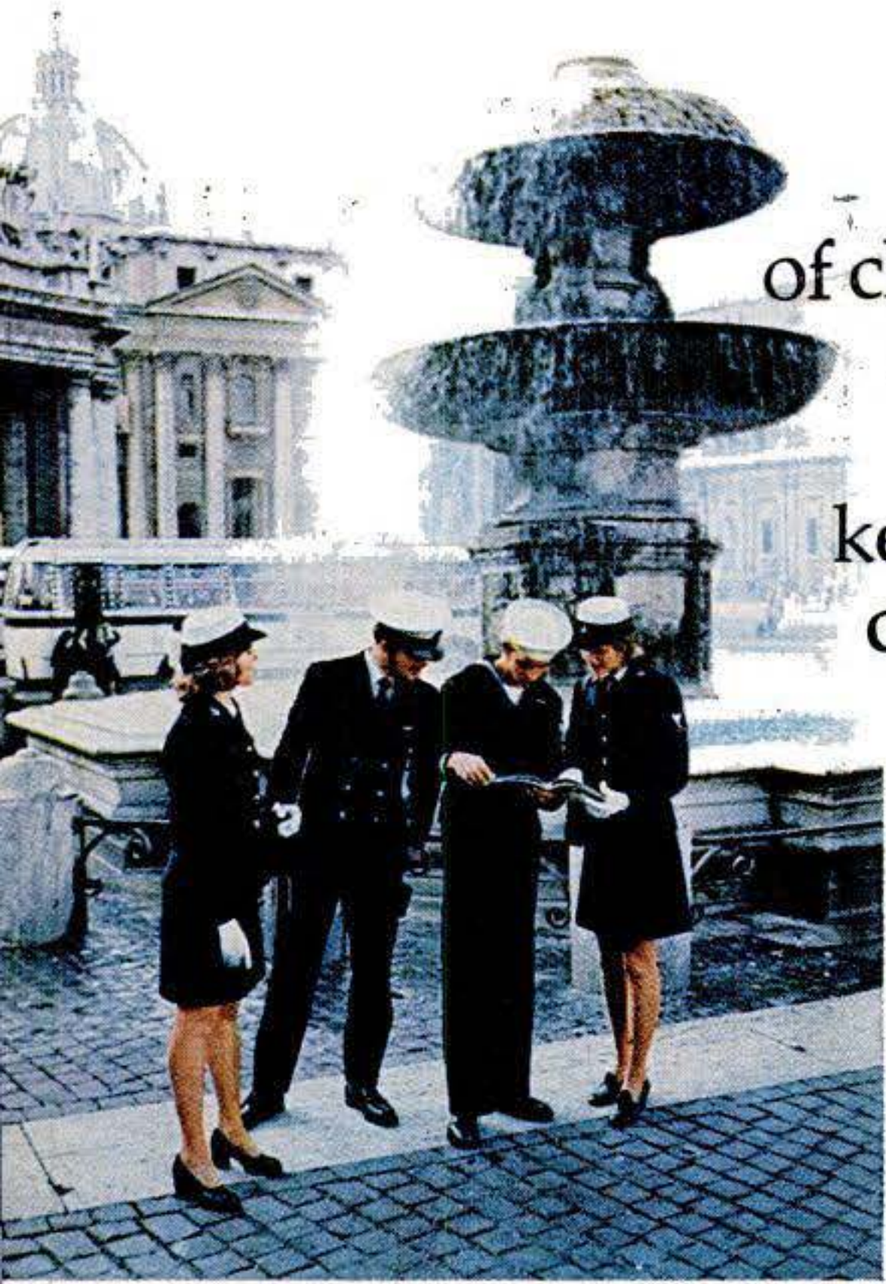

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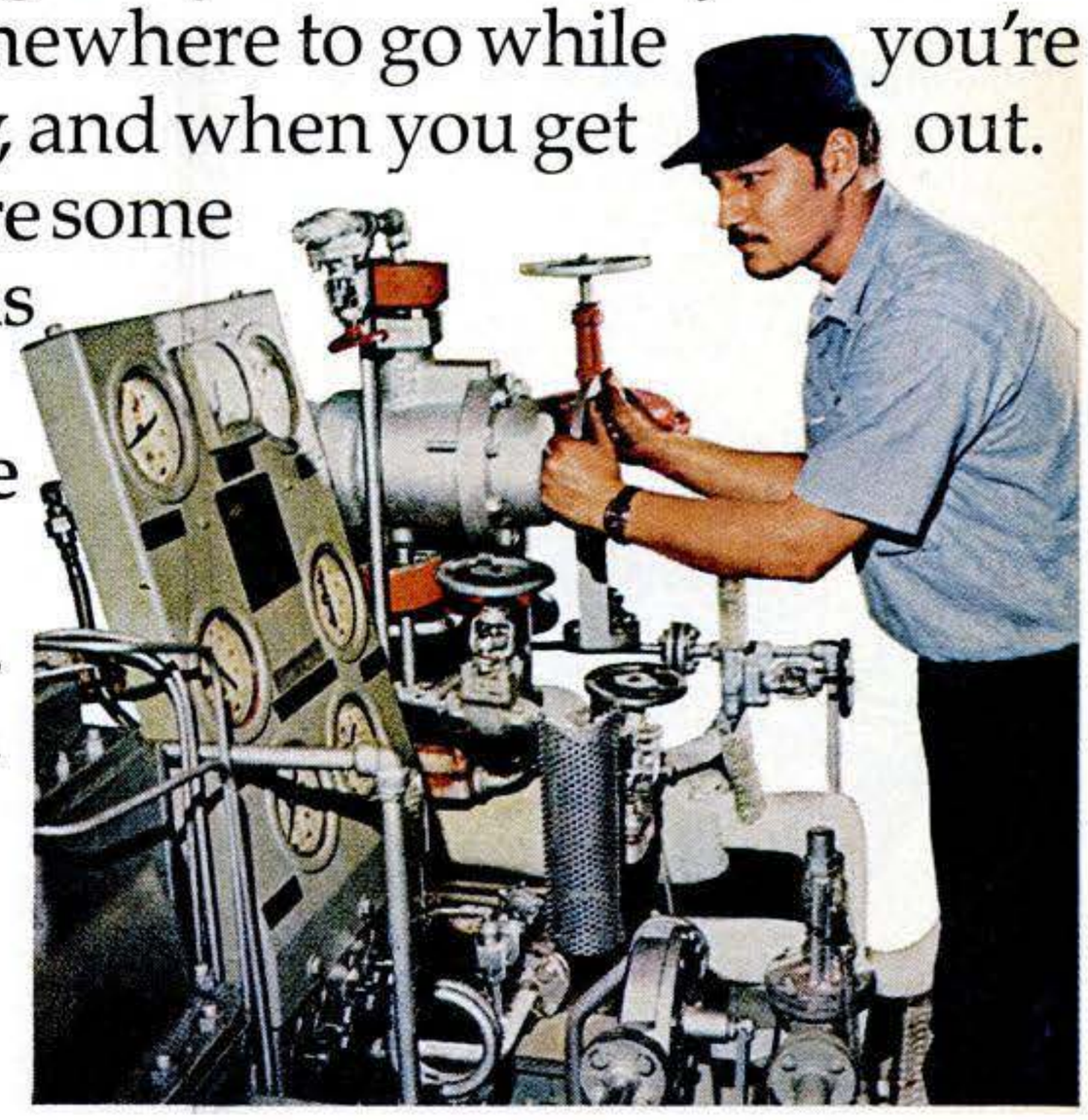

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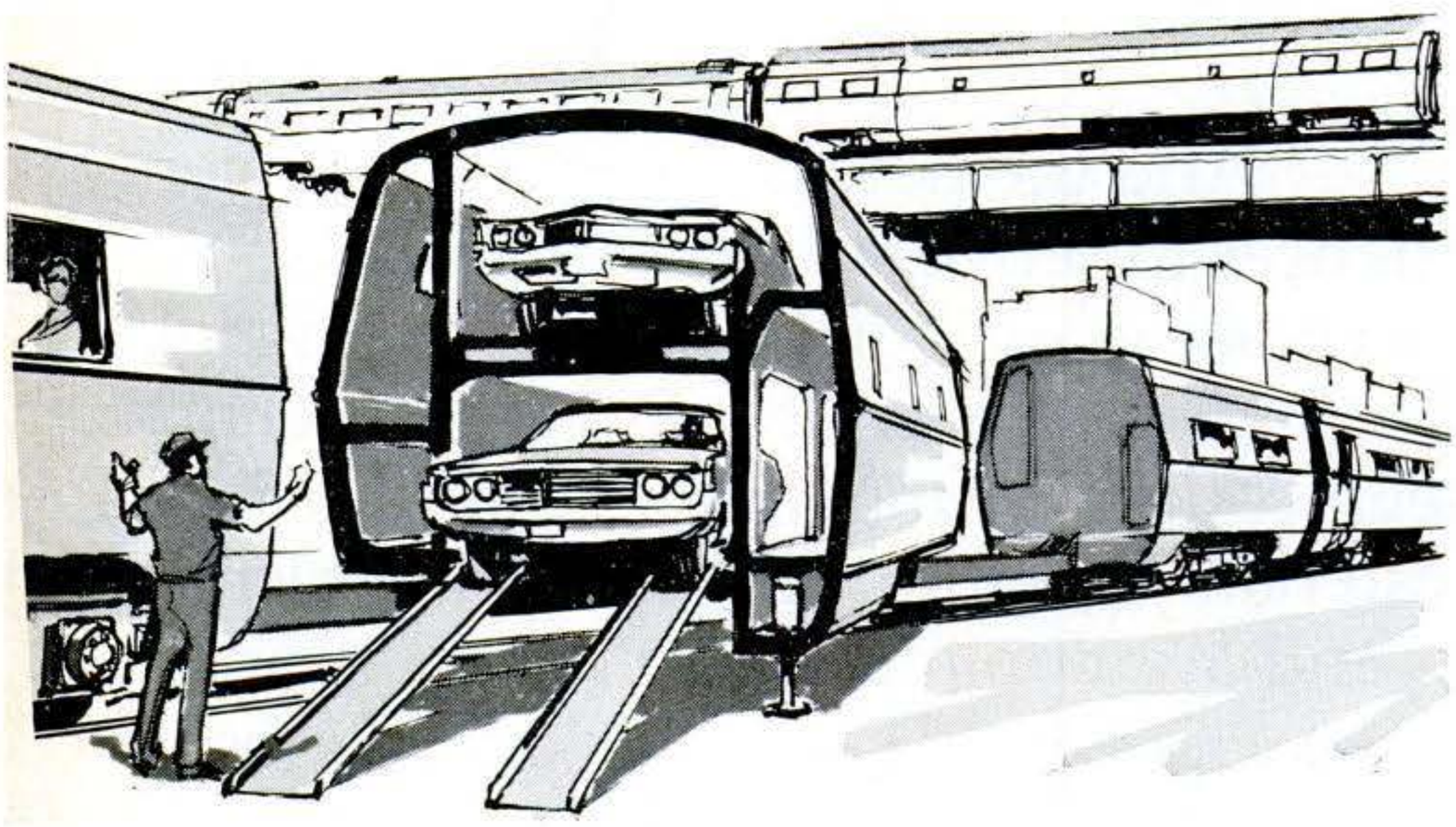
New Ideas from the Inventors

The PS pick of ingenious inventions recently patented

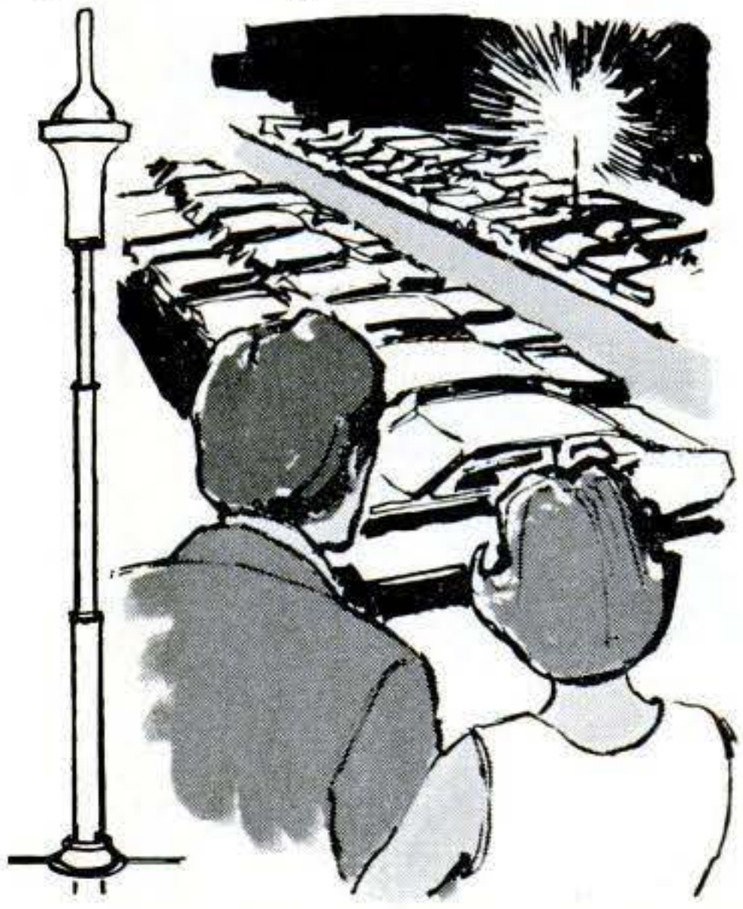
ILLUSTRATIONS BY DANA RASMUSSEN



Passenger train carries passengers' cars

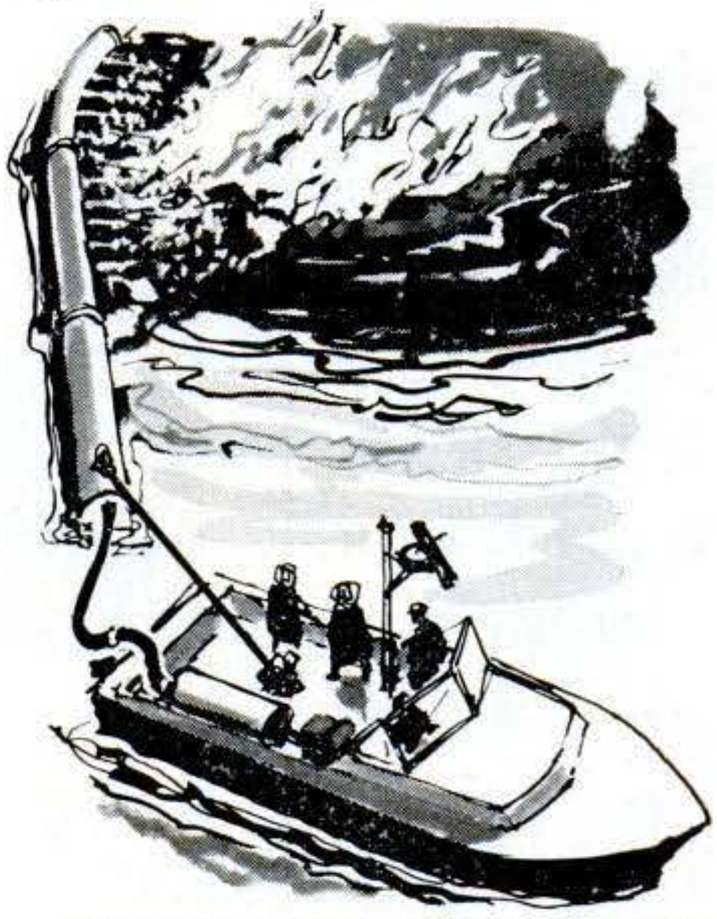
You might break a long train trip into convenient driving and riding legs if railroads offered a combination car like this. Pivoted on a flat bed, the double-deck auto-park midsection would swing out, in stations, so cars could be ramped off or on. Along the way the car-carrier would nest between the engineer's cab and a passenger coach or lounge. Permanent drive-on platforms for both levels might be provided at some larger stations.

Light locates parked auto



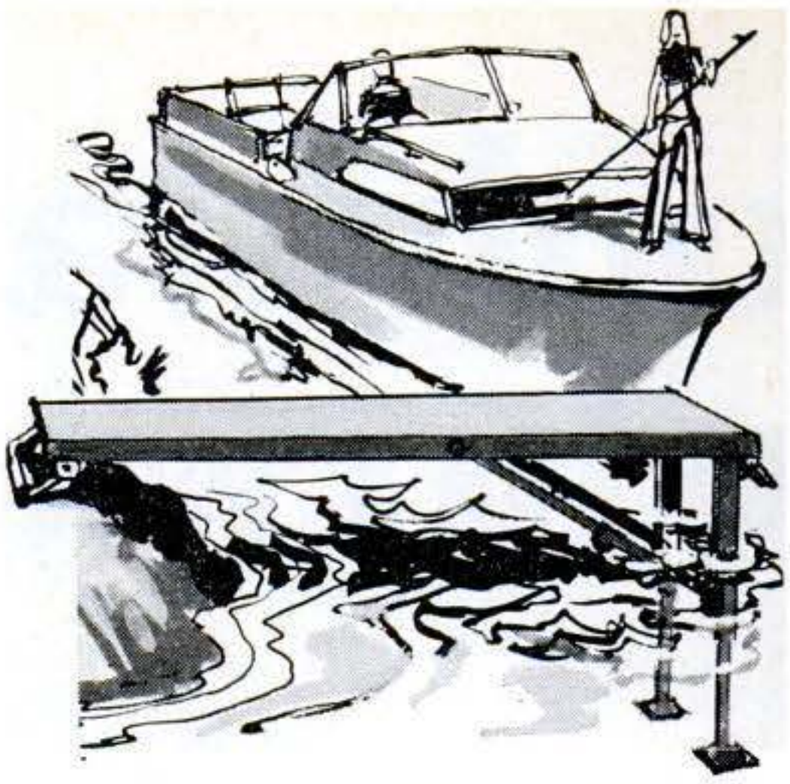
Lifted from a fender socket, the lighted tip of this telescoping rod would help you spot a car quickly in a crowded lot. The low-drain light could be made in several identifying colors. Manually switched, it would be most useful for short signal periods, as for shopping at night or for finding your way back from the snack bar at a drive-in movie.

Air jets burn off slick



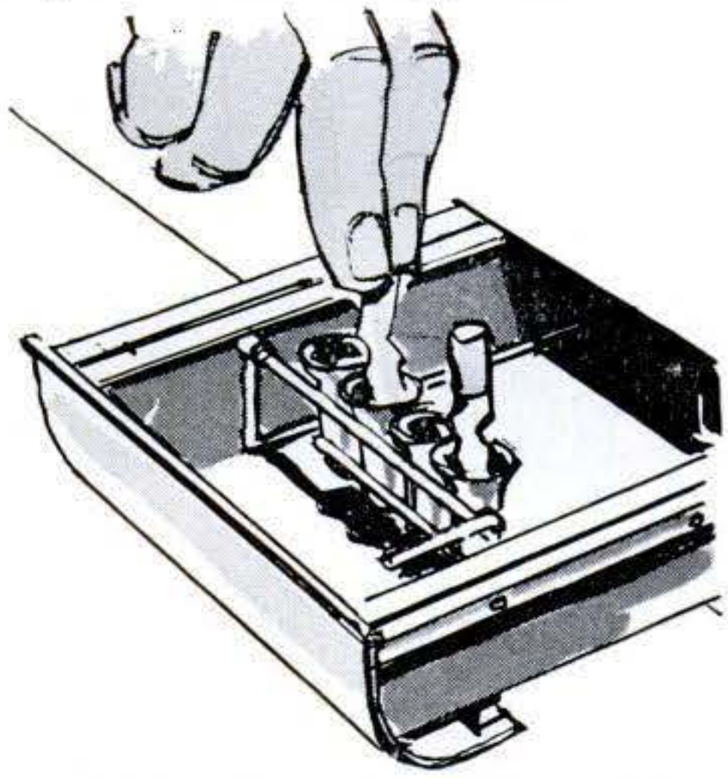
Attempts to burn spilled oil off a water surface are often defeated by the cooling effect of the water. Controlled combustion could be aided, say these inventors, by containing the slick within tubes spread by boats or booms. Air injected into the flame through jets in the tubes would help to burn the slick faster and more completely.

Dock travels with boat



This lightweight, portable gangplank, with legs pivoted at the shore end and extensible at the boat end, would let you set up a convenient dry-boarding waterfront camp at any likely point along the shore of a lake or river. Adjustable for different shore contours and bottom slopes, the legs of the go-anywhere dock would fold flat for compact on-board transport as well as for off-season storage.

Tray insert snuffs cigarettes



While driving, you'd kill a cigarette without showering sparks or diverting your attention from road and traffic by dropping the lighted tip into the flared end of a snuffer tube on this spring-biased insert. The insert would fit into most types of dashboard ashtrays. When convenient, you could touch a lever that would turn the insert over and empty accumulated, safely extinguished butts into the ashtray.

The following patents have been issued on these inventions:
Car train—*No. 3,584,584 to V. Milenkovic, Boulder, Colo.;* **Carlocater**—*No. 3,578,964 to R. H. Sherman, Georgetown, Mass.;* **Slick burner**—*No. 3,586,469 to A. Molin, Saltsjobaden, and O. Carlsson, Nacka, Sweden;* **Portable dock**—*No. 3,568,451 to V. H. Gustin, Kansas City, Mo.;* **Ashtray snuffer**—*No. 3,586,008 to E. J. Fredette, St. Boniface, Manitoba, Can.*
Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington, D. C. 20231, at 50 cents each. To write to an inventor, if the address above is insufficient, address him (by name and patent number) in care of the Commissioner of Patents.

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PS Ratings—Test Report in a Nutshell

The table below shows our ratings for the four cars (Dodge Coronet Custom above at left, Buick Century Luxus behind it, Mercury Montego MX between Dunne and Norbye, Pontiac Grand Am at right). Ratings are based strictly on test results and measurements, not on subjective opinion. Five points is excellent; 4, very good; 3, good; 2, fair; 1, poor; and 0, very poor.

	Buick	Dodge	Mercury	Pontiac
Acceleration	3	5	5	5
Brakes	2	3	3	3
Handling	1	1	0	3
Maneuverability	3	4	1	5
Fuel economy	0	1	0	1
Quietness	3	3	4	4
Ride comfort	(4)	(3)	(5)	(4)
Roominess	4	4	4	4
Visibility	2	1	0	3
Entry/exit	4	5	4	4

POPULAR SCIENCE · CAR TEST · NORBYE/DUNNE REPORT

Pontiac's new Grand Am comes face to face with some of its competitors and forcefully demonstrates why it truly belongs in a class of its own

Top-of-the-Line Intermediates:

A mixed bag of family sedans

By JAN P. NORBYE/*PS Automotive Editor*
and JIM DUNNE / *PS Detroit Editor* PHOTOS BY ORLANDO GUERRA

When we first drove the Grand Am at the GM Proving Grounds last summer, we recognized it as a new type of car. It's a kind of car Detroit has never built before. So we knew the cars in this group would not be evenly matched. To understand why, you have to look at what the Grand Am is and how it was engineered.

Pontiac's goal was to build a car with superb handling without giving up anything in the way of ride comfort. As a rule, the things that improve handling also destroy the ride.

Continued

How PS tests brakes—and what we learn from it

We test a car's ability to stop within a 12-foot-wide lane from 60 mph without front-wheel locking. Test is made first with cool brakes to show brake capacity and balance. Next come 10 warmup stops from 60 mph at one-minute intervals with 0.5-g deceleration. Minimum-distance stop is then repeated to show fade resistance. Left, top, Dodge throws smoke from locked rear wheels, shows steering correction needed to keep within lane as rear wheels try to pull car sideways. Dodge stopped in short 130 feet with cool brakes; 148.3 feet after warmup (14% deterioration). Pedal pressure rose from 90 pounds to over 200. Retardation exceeded 1 g in first stop, reached 0.95 g in final stop. Below, Mercury smokes from locked rear wheels. Cloud from front wheel is just heat from disk brake. Cool-brake stopping distance was 134.3 feet; car needed 157.8 feet in final stop (17.5% deterioration). Pedal pressure doubled from 60 pounds needed in first stop. Peak retardation was fractionally short of 1 g on both stops. Buick suffered 22% deterioration after warmup, and pedal pressure tripled from 60 pounds needed on first stop. Peak retardation fell from 0.95 g in first stop to 0.72 g in final stop. Grand Am had shortest hot-brake stopping distance, with 11% deterioration. Pedal pressure more than doubled. Peak retardation held high: 0.96 g in final stop.

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This symbol stands for one of the five kinds of bike riding. Honda has them all. Like Road Bikes.

Like you on a Scrambler 175 K6 or a Super Sport 175 K6. Escape time! Trees and houses and sky flashing by. Your engine humming baritone. You smiling. The world smiling back.

Our middleweights. Designed for the easy ride. The responsive four-stroke 174cc engine features an overhead cam. Plenty of scat, mated to a slick-shifting five-speed constant-mesh transmission. Cradled in a road-tuned suspension. Smooth. Economical. Dependable.

Honda's style. Its standard equipment: Chrome fenders. Polished engine. Rich buffed paint. Dashing stripes and emblems. Big headlight. Speedometer and tachometer. Turn signals. Flip open gas cap. And the pipes! The Super Sport has fine sweeping chrome duals. The Scrambler's muffler is wild sculpture, set high. Protected on the trail.

They're both at Honda Land now. Where you'll find Honda has it all. There's a dealer near you. Near most everywhere: The biggest bike parts/service network in the USA.

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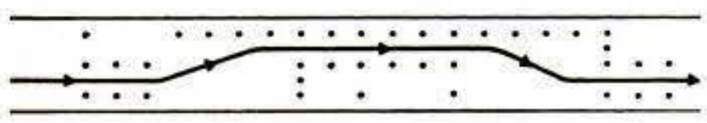
From Mighty to Mini, Honda has it all.

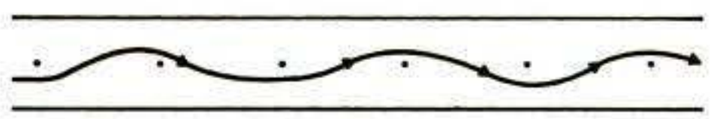
We recommend that you always wear a helmet and eye protection, keep your lights on and check local laws before you ride. Check the full Honda model designations including K numbers which indicate model changes. For a free brochure, write: American Honda Motor Co., Inc., Dept. QR, Box 50, Gardena, Calif. 90247. ©1973 AHM.

Standardized handling test shows evasive ability



Two lane changes in quick succession show a car's handling precision in a high-speed emergency maneuver. The car swerves left to avoid a barrier in right lane. Left lane is blocked 120 feet beyond right-lane barrier. Open lane-change gaps are 60 feet long. A car is driven through grid several times (stopwatch-timed). Fastest time without hitting rubber pylons gives average speed for best run. Above, Grand Am speeds through at 60 mph, without body roll and in very composed attitude. Only flexing in tire sidewalls betrays enormous cornering forces generated in tire footprints. This family sedan equaled speed of Firebird we tested two years ago! It has admirable stability, mild understeer. Steering response was not as fast as Firebird's, but remarkable for such a heavy car. Buick was next, with 54.5 mph; then Dodge, at 53 mph; finally Mercury, at 49.9 mph—more than 10 mph slower than the Pontiac. Its problem was excessive understeer, slow response.

PS maneuverability test tells all about steering



Driving as fast as possible on a snake course between pylons spaced at 48 feet is a severe test of the entire steering system. Any shortcomings in choice of steering ratio, power-steering reactivity, roll-steer phenomena, turn diameter (maximum steering angle), and tire stability and sidebite, will show up in reduced speed. Cars that can take this test at 26 mph or more have excellent maneuverability. Slower cars have reduced evasive ability. Below: Buick on its way through the course at 24.6 mph despite pronounced body roll and firm understeer. Fastest car was Pontiac, at an even 26 mph. Dodge was second-best, with 25 mph. The Mercury was hampered by excessive understeer and slow-geared steering and could not do better than 22.1 mph.

Police cars, for instance, have great handling characteristics, but a terrible ride. That's because they have extra-stiff springs.

Pontiac Grand Am. Pontiac's approach was different. Spring rates are the same as on the regular Le Mans. The chassis engineers built handling precision into the car by other means. They started with the

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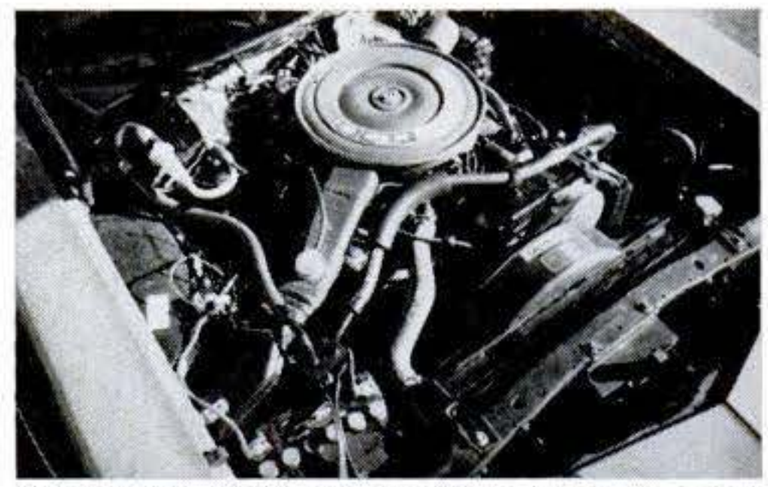
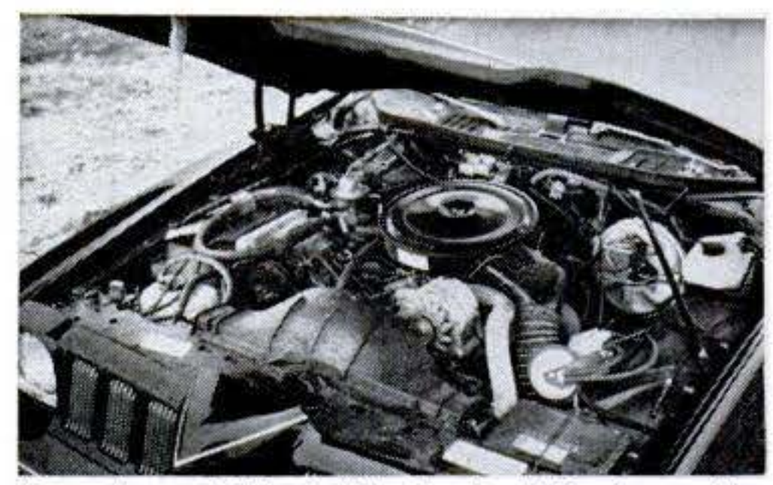
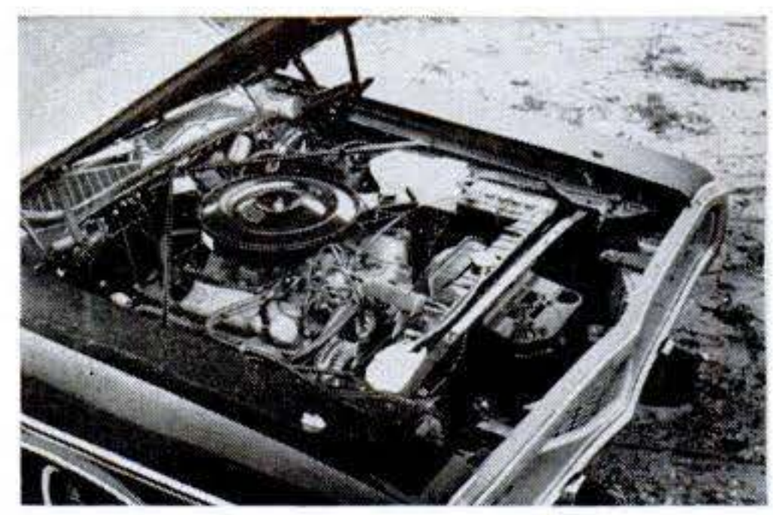


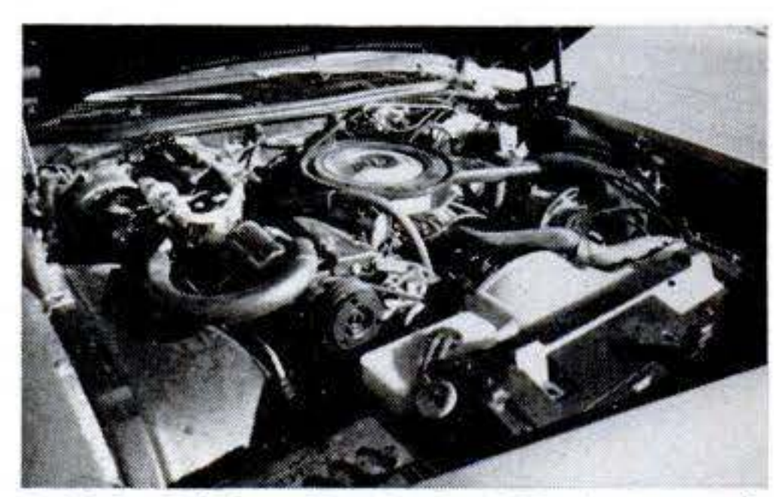
Mercury 429-cubic-inch V8 is easy to work on. Right-bank plugs are a little tricky, but no problem. Distributor sits on front of the block.



Pontiac 455-cubic-inch V8 has distributor at rear of block, down in the V. Right-bank plugs are hard to reach because of the air-conditioner.



Dodge 400-cubic-inch V8 has exhaust manifolds above spark plugs. Left-bank plugs are very hard to reach due to power-steering installation.



Buick 350-cubic-inch V8 has semi-closed cooling system and fan shroud incorporating coolant reservoir. All service points are easily reached.

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When all the roads start to feel like railroad tracks, you know it's time for new shocks.

But maybe you don't know there's more than one type. That's where your Delco man comes in. He has three different types to offer, and he'll be happy to let you know which one is just right for you.

For example, if you spend a lot of time on the highway or especially rough roads, Heavy Duty Delco Pleasurizers are designed to help make riding smooth and handling easy. For city driving, regular Delco Pleasurizers can ease you over the irregularities of city streets. Delco Pleasur-Lifts give the same ride control under normal driving conditions and are easily air-adjustable to help your car haul boats, trailers or carry heavy loads.

When you know you need new shocks, you ought to know you have a choice. So let a Delco man tell you about Pleasurizers, Heavy Duty Pleasurizers and Pleasur-Lift shock absorbers. After all, it's his business to know what's right for your car.

THE MORE YOU KNOW, THE MORE YOU'LL WANT DELCO.

WHEN YOU NEED NEW SHOCKS, YOU OUGHT TO KNOW WHICH TYPE.

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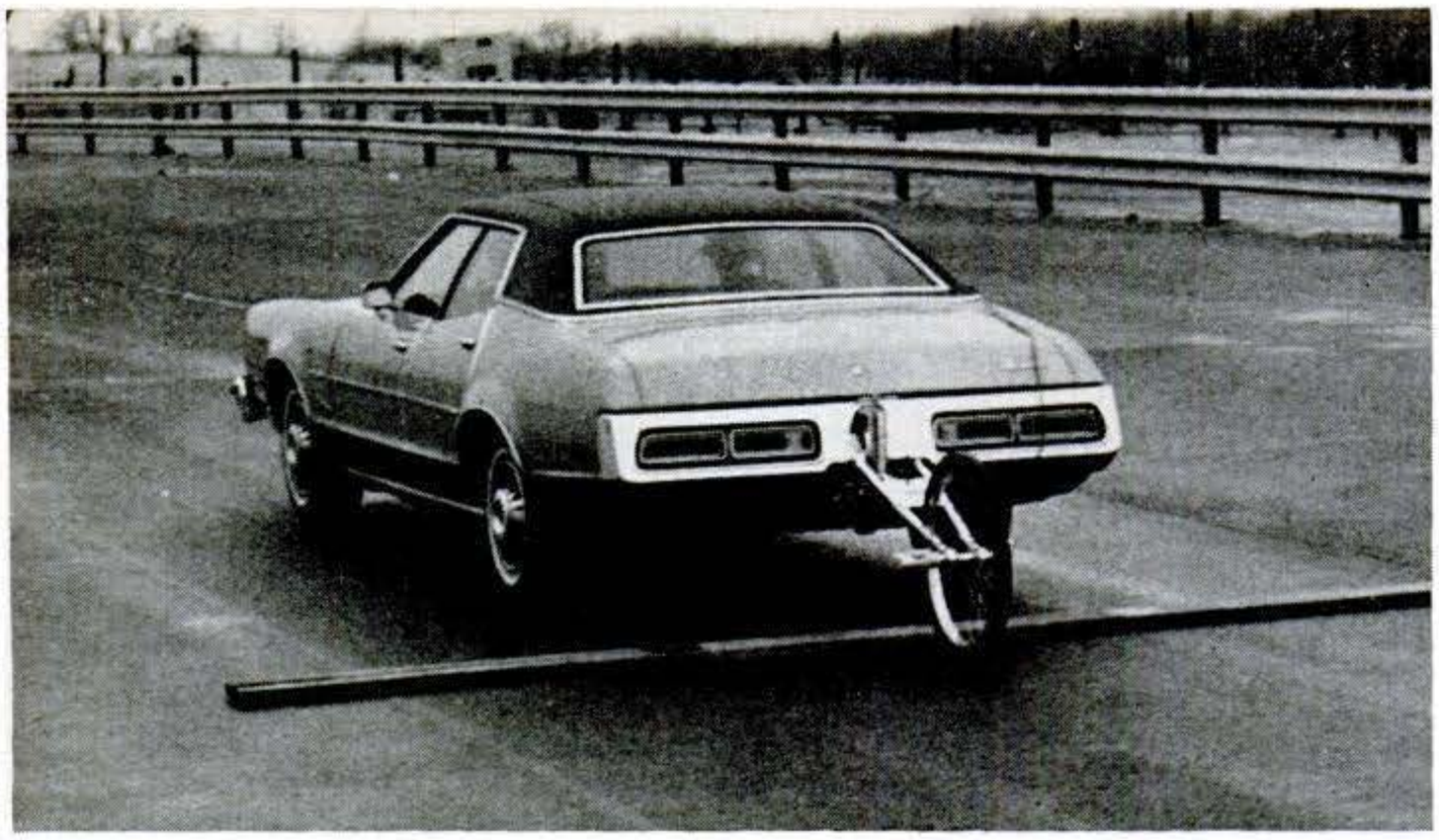
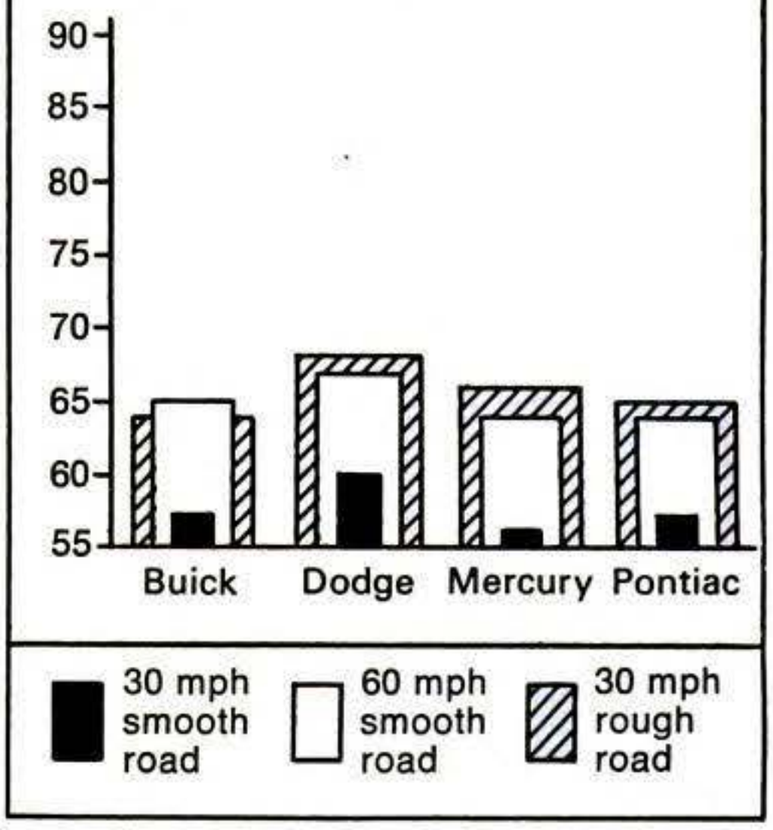


Ride-comfort test uses single bump on a smooth road

Test plank is two inches high and eight inches wide. Test speed is 60 mph. Vertical accelerations in the front seat are sensed on a Uher tape recorder. The tape is played back on an oscilloscope, and the scope is then photographed with a special Polaroid camera. From the picture we can then measure the amplitude, frequency, and duration of the disturbance. Above: the Mercury Montego, which rates a full 5 points for ride comfort.

NOISE-LEVEL TESTS

Interior noise is measured in decibels on the A scale on our standard General Radio sound-level meter applied under three sets of conditions. A reading of 50-dbA is like an average residence. A 60-dbA reading is like a large store; 70-dbA, like a freight train going by 100 feet away; 80-dbA, like a pneumatic drill at 50 feet.



tires—wide steel-belted radials. The shock absorbers are special, giving very high resistance in jounce and rebound. The rear-suspension control arms have special bushings in their frame anchorage points. Finally, they added a stabilizer bar in the rear suspension, and fitted a stronger stabilizer bar at the front end.

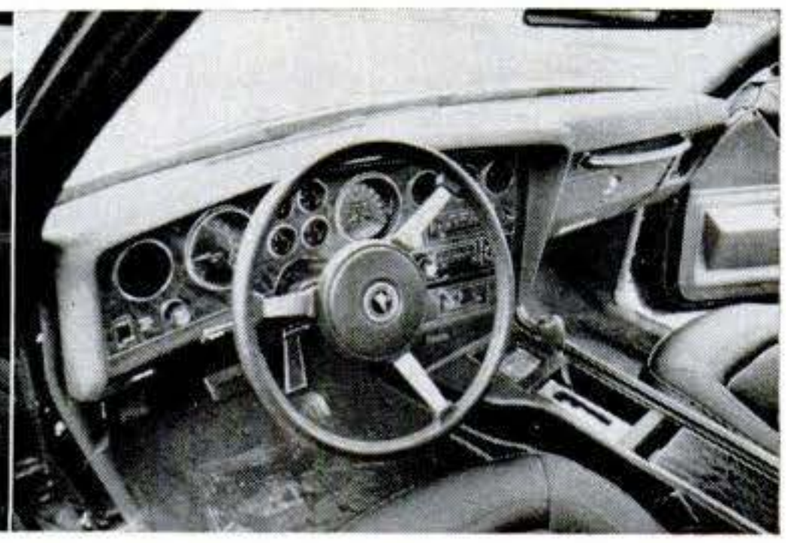
How well did they succeed? Our ratings will tell you that the Grand Am has the same soft ride as the Buick. It's as quiet as the Mercury. In the handling tests it set records never before reached by a car of its size and weight.

Pontiac claims the Grand Am was intentionally developed to be one of America's premier touring cars. The test results prove they succeeded. They did not try to build a Mercedes or a Jaguar, but they incorporated a number of European design elements. With the optional 455-cubic-inch V8, the Grand Am has ample power. We were surprised to see that it also returned creditable gas mileage. In fact, it burned less fuel than the Buick with its four-barrel 350-cubic-inch V8.

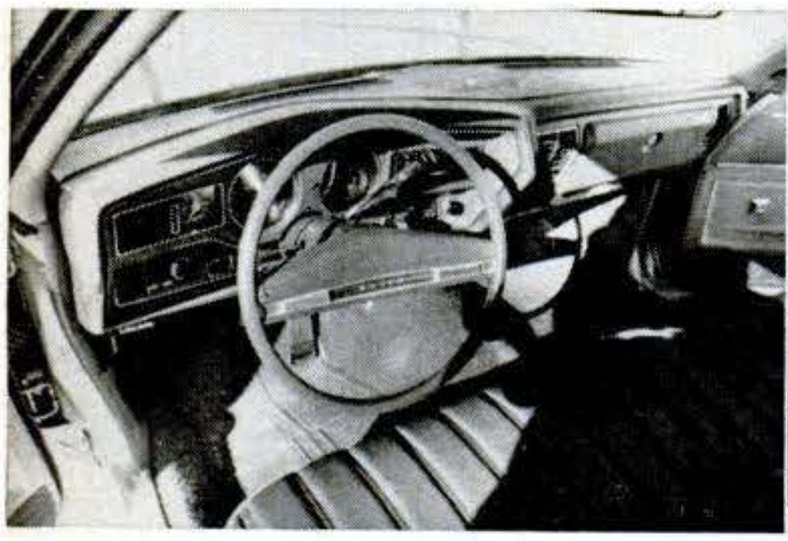
The Grand Am cockpit was designed for the enthusiast. He gets complete instrumentation, console shift, and a sports-type steering wheel with a softly cushioned plastic rim and a large no-nonsense horn button in the middle. The brake re-

Continued

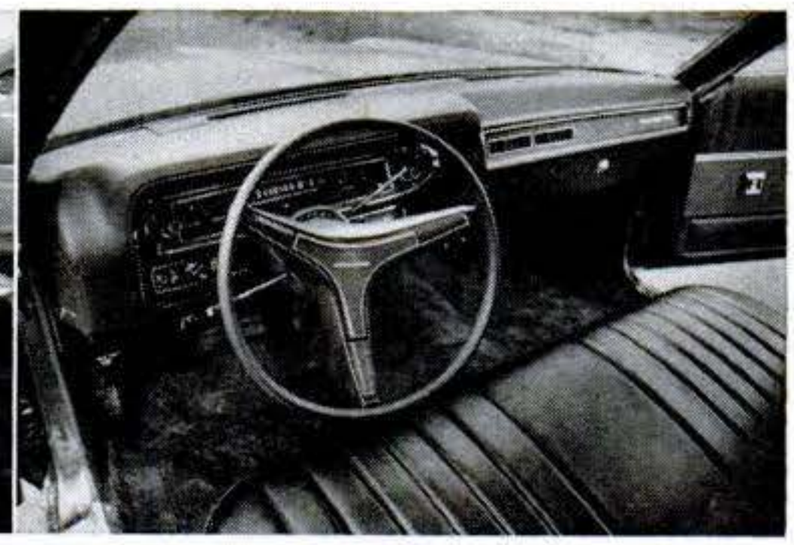
Montego four-pod instrument cluster includes temp gauge and clock. Glove box is on bottom of panel, hard to reach into, and offering little space.



Grand Am instrument panel, borrowed from Grand Prix, has tach, oil-pressure and temperature gauges. Wiper switch is on far left, beyond light switch.



Buick has sparse instrumentation but lots of warning lights. Radio, heater are on right, where passenger can reach; wiper-switch arrangement like Pontiac's.



Dodge has gauges for fuel, temperature, and alternator. Heater controls are on left, in driver's reach only. Light switch is far left, wiper at right.

Driver's seat in Grand Am has reclining backrest, adjustable lumbar support. But seat cushion gives poor thigh support despite contoured shape.

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Coleman

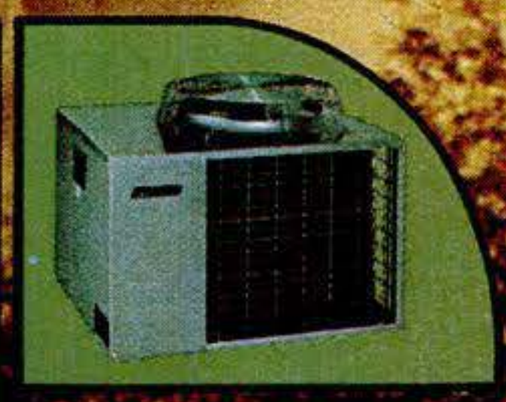
Make her feel at home Sweepstakes

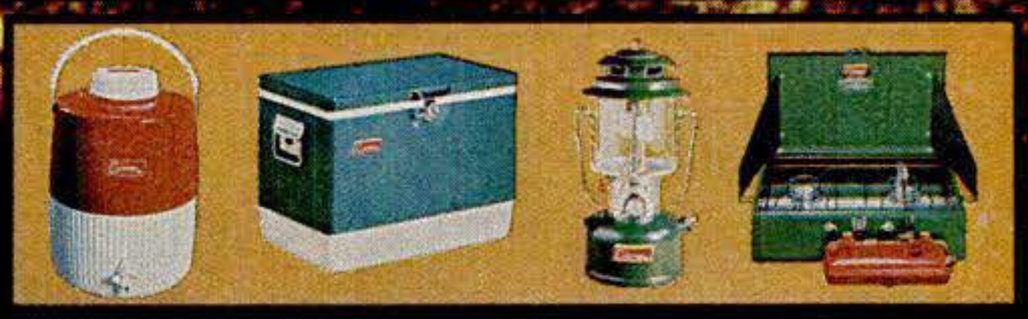
Cool test Coleman RV Air Conditioning and enter today!

5 — GRAND PRIZES — FREE TRIPS FOR TWO TO PARIS, 5 — 1ST PRIZES — COLEMAN PRESIDENTIAL CENTRAL AIR CONDITIONING, 50 — 2ND PRIZES — COLEMAN CAMPING PACKS, 75 — 3RD PRIZES — COLEMAN CROSMAN AIR RIFLES, 100 — 4TH PRIZES — COLEMAN POLY-LITE COOLERS, 200 — 5TH PRIZES — COLEMAN SNOW-LITE PICNIC JUGS

"Cool-Test" famous Coleman Recreational Vehicle Air Conditioning and you may win a glorious all-expense paid week in Paris for two!...Or any one of the famous Coleman Products! That's right! Just drop by your nearest participating Coleman RV Air Conditioning dealer for an entry blank or send in a 3 x 5 card as described in the official contest rules. Ask for a demonstration of any one of the three famous Coleman RV Air Conditioners — Mach 1 (10,000 BTU's) — Mach 2 (12,000 BTU's) — Mach 3 (13,500 BTU's). Demonstration is not a requirement to enter the sweepstakes.

Sign up now and you may walk out a winner!





OFFICIAL RULES

1. Enter as often as you like at your participating Coleman RV Air Conditioning dealer on an official entry blank or print the words, "Coleman RV Air Conditioning" plus your name, address and zip code on a 3" x 5" card and mail to International Incentives, O'Hare Office Bldg., Suite 511, 10600 W. Higgins Road, Rosemont, Illinois 60018.
2. Winners will be determined by a random drawing. Decision of International Incentives, Inc., who will act as independent judges, will be final.
3. Sweepstakes is open to all licensed drivers who are residents of the United States and who are 21 years of age or over, except the employees of the Coleman Company, Inc., its subsidiaries, advertising agencies or International Incentives, Inc. Will be void in the states of Connecticut, Delaware, Florida, Georgia, Idaho, Iowa, Missouri, Nebraska, New Jersey, Washington, and wherever else prohibited or restricted by law. All federal, state and local laws and regulations apply.
4. No purchase is necessary. All prizes will be awarded. Prizes are non-transferable and non-redeemable for cash. No substitutes are offered. The odds of winning will be determined by the number of entries.
5. Federal, state and local taxes, if any, are the sole responsibility of the winners.
6. A list of winners will be sent to those who request them. To obtain a list, send a stamped, self-addressed envelope to Coleman Sweepstakes Winners, International Incentives, Inc., O'Hare Office Bldg., Suite 511, 10600 W. Higgins Road, Rosemont, Illinois 60018.
7. Contest begins February 1, 1973 and ends July 15, 1973. Entries must be post-marked prior to closing date. Trips to Paris must be taken in September or October, 1973, as designated by The Coleman Company. All other prizes will be shipped directly to the winners, freight prepaid.

See your nearest Coleman RV Air Conditioning Dealer today or write for *Free Color Literature!*

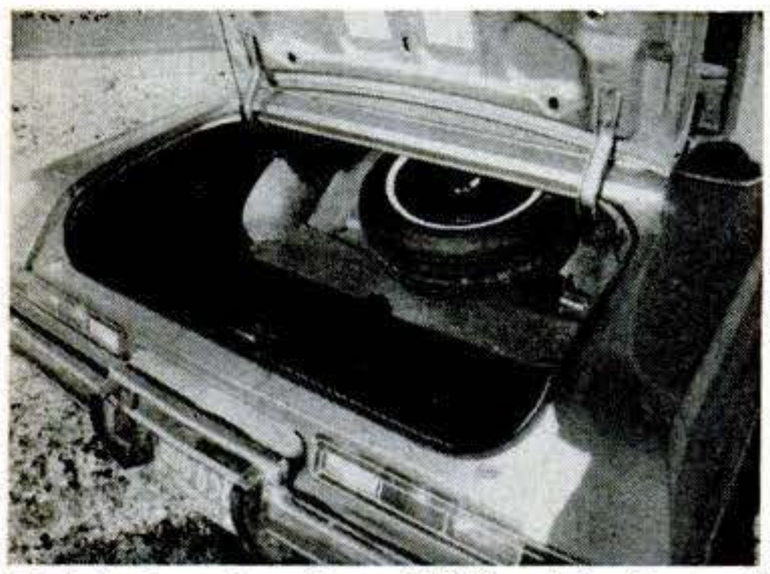
Coleman

THE COLEMAN COMPANY, INC., Recreational Heating & Air Conditioning Products Division, Wichita, Kansas 67201

Greatest name in the great outdoors.

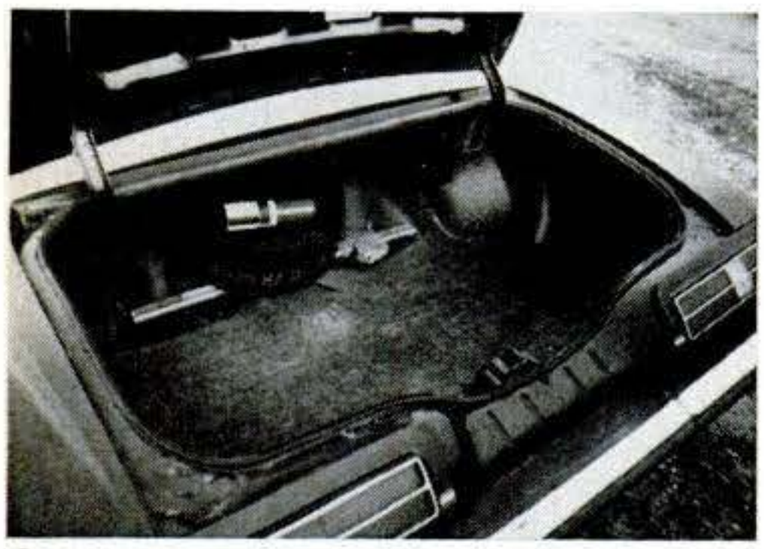
lease is up on the instrument panel, where it can't be confused with the hood release. The seats are unique (for American cars) with reclining seat backs and adjustable lumbar support.

Interior trim is notable; it goes one step further than the typical all-plastic and bisquited cloth of most U.S. cars. The Grand Am's wood grain has a hand-rubbed and polished appearance. Instruments are framed in bright metal. Each door has a leather strap. There's also a grab handle on the panel above the glove box. Small change dishes are molded into the front armrests. The center console has an extra storage bin.



Buick trunk offers 15.6 cubic feet of useful space, liftover is 21.4 inches. Lid is not full width of trunk floor.

Dodge trunk has extra-wide lid, low, flat floor. Useful space is 16.5 cubic feet, and liftover height is 27 inches.



Grand Am trunk has space-saver spare tire, but only 15.1 cubic feet of space. Slope of deck cuts into the space.

Mercury trunk has 14.8 cubic feet of useful space, and 29.1-inch liftover height. Lid is almost full width.

Unfortunately, the seats aren't as comfortable as they look, for the seat cushions are too small to give proper thigh support. Large seat-belt holsters take up foot room in the rear floor area, and get dirty quickly because frequently stepped on.

Exterior styling is unusual, and the front end, with its vulnerable-looking nose piece, does offer full protection against damage in a five-mph crash. The urethane-rubber front collapses, then pops back into shape.

Buick Century Luxus. Cousin of the Grand Am, it shares the same basic body and chassis components. But Buick's marketing strategy is very different from Pontiac's; the 455-cubic inch Buick V8 is not available in the highest-priced intermediate (it's offered on two-door models only).

This car is definitely lacking in performance. Still, the engine is very quiet, blending perfectly with the car's smooth, sedate, civilized character. It has the ride comfort of the Grand Am, but not the handling and maneuverability. Still, it's a sound, well-balanced car of safe, predictable road behavior.

Brake performance was disappointing, since so many Buicks we've tested in the past have had phenomenal brakes. This one rates only two points for brakes, while the other cars in this group rated three each.

The Century Luxus has a practical bench-type front seat, and the car seats six in relative comfort. But the Fisher Body seat design provides little thigh support, increasing the risk of driver fatigue.

Instrumentation is neat, simple. The glove box is small, but Buick has been smart enough to put the lid high on the panel where it's handy. The parking-brake release is on the bottom of the panel, left side, but the hood release is farther down, so there's not much chance of mistaking one for the other.

Dodge Coronet Custom. This car conforms more closely than its rivals to the traditional all-purpose family sedan. It's big and roomy, with a minimum of frills. It has the best ease of entry and exit.

It's designed to be practical, with maximum convenience for all occupants. Vinyl seats and door trim make for a very serviceable interior. The interior decor is simple, yet not lacking in necessities. It's laid out for roominess, not style—one of the few modern cars in which you can wear a hat and still be comfortable.

Instrumentation is above average, as in most Chrysler products. A very large ashtray is in the middle of the instrument panel, and contains the lighter. There are two face-level vents, augmented by two individually controlled outlets below the panel. Hood lock and parking-brake release, only two inches apart under the panel, on the left, can be confused. Front seat is bench type, with center armrest and built-in headrests.

The 400-cubic-inch V8 is a quiet and reliable workhorse. With the two-barrel carburetor it gives better-than-

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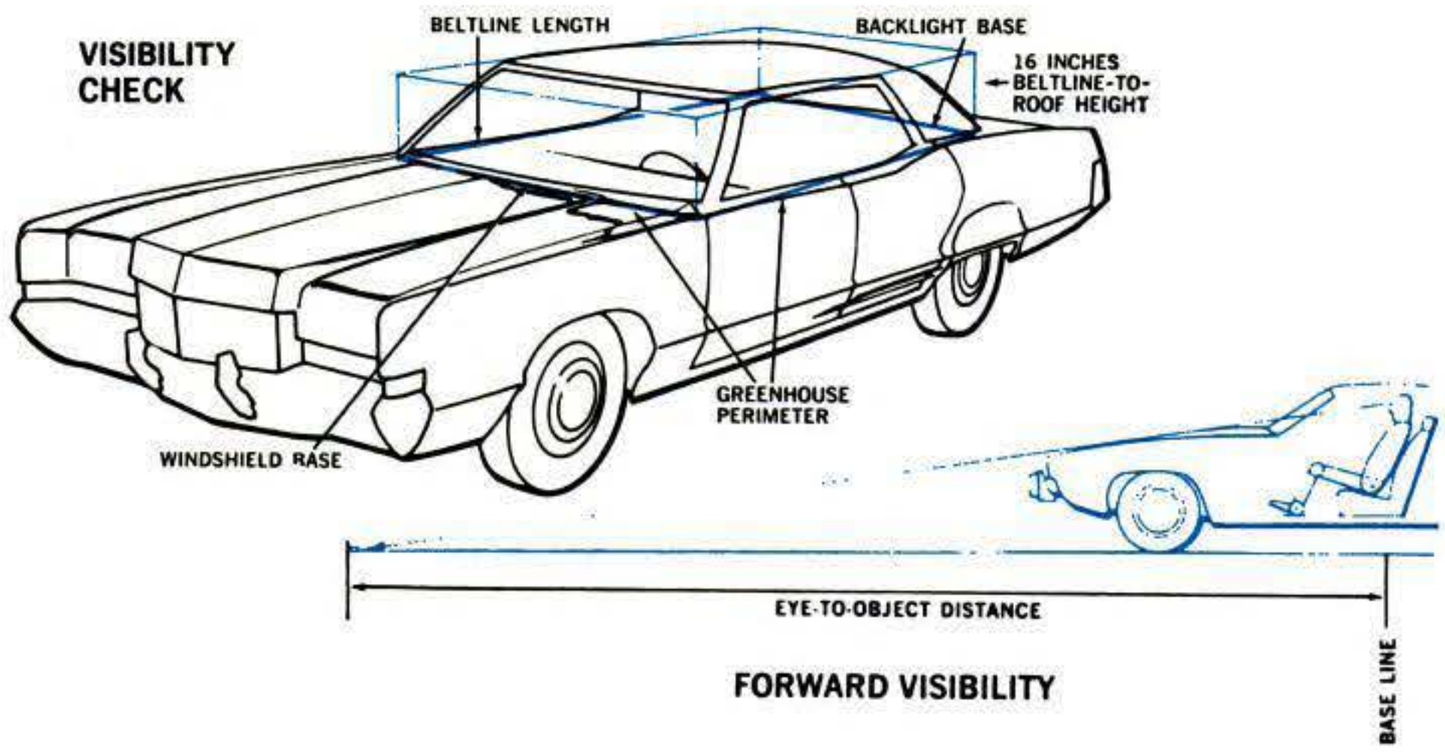

Visibility index is based on actual glass area compared with total greenhouse side surface, and distance from driver's eye to a ground-level object directly in front of car. Small windows and long, high hood lines penalize car. Also, cars with wide sail panels get a low rating.

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Photographed on English Bay, looking toward Vancouver from mainland British Columbia.

CANADIAN WHISKY—A BLEND, 80-86.8 PROOF, BROWN-FORMAN DISTILLERS IMPORT COMPANY, N.Y., N.Y. ©1972.

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expected gas mileage, yet it has enough performance potential to rate a full 5 points for acceleration, right along with the 455 Pontiac and 429 Mercury. Electronic ignition is standard. Chrysler's unit-construction B-body has been reasonably well soundproofed for '73, but the Coronet still has higher noise levels than the other intermediates. It has a low rating for ride comfort. The Chrysler intermediates use leaf springs in the rear suspension; Ford and General Motors use coil springs all around on their intermediates.

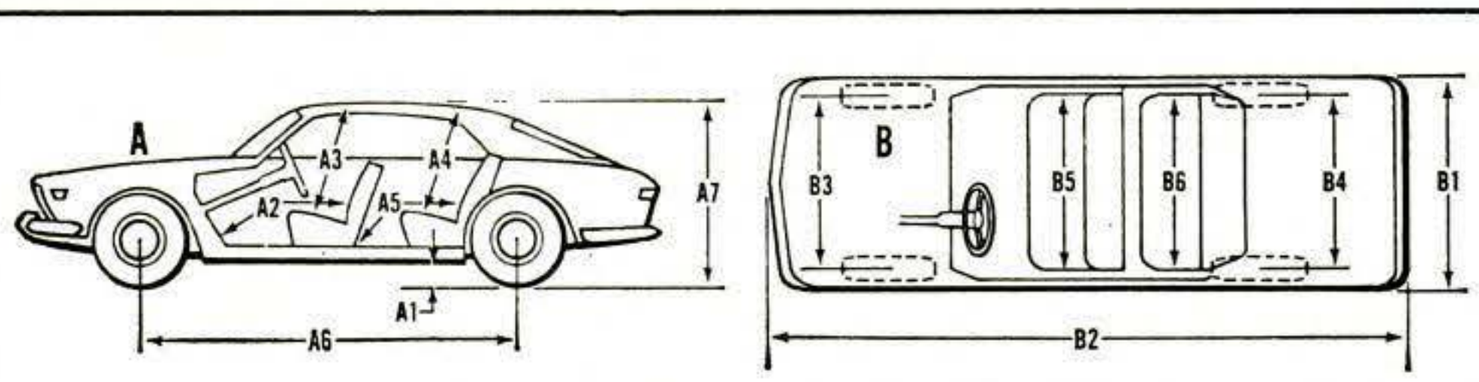
Mercury Montego MX. This luxury car has a high-grade interior finish and trim, on a par with many higher-priced models. It's the most ostentatious of the cars in this group.

But we have complaints: The seats are low, the belt line high, the hood long, and the windows small. Large sail panels cut off an important viewing area. Visibility rating is 0.

On the plus side, the Montego lives up to its claims for a quiet ride. It has been achieved at the expense of handling, however. The car understeers with slug-like persistence. It has minimal evasive ability, and rates 0 for handling.

Parking-brake and hood-release handles, right next to each other, are easily confused. The glove box is small and inconveniently placed. The instrument panel has four face-level vents, no cowl vents.

Acceleration times were slower than expected from the big 429-cubic-inch V8, easily beaten by the Dodge with its smaller engine and two-barrel carburetor. PS



DIMENSIONS (inches)	BUICK	DODGE	MERCURY	PONTIAC
A1 Ground clearance	4.8	6.3	4.5	4.7
A2 Front leg room (max.)	42.5	41.9	42.1	42.4
A3 Front head room	38.3	38.5	38.3	38.3
A4 Rear head room	37.5	37.3	37.3	37.5
A5 Rear leg room (min.)	38.4	36.7	37.6	38.6
A6 Wheelbase	116	118	114	116
A7 Height	54.4	53.6	53.0	54.3
B1 Width	78.0	77.8	78.6	77.7
B2 Length	212.4	212.9	215.3	212.6
B3 Front track	61.5	61.9	62.8	61.9
B4 Rear track	60.7	62.0	62.9	61.1
B5 Front hip room	56.6	59.2	59.4	56.0
B6 Rear hip room	57.9	59.2	59.4	57.9

SPECIFICATIONS				
Engine type	OHV V8	OHV V8	OHV V8	OHV V8
Displacement (cu. in./cc)	350/5737	400/6556	429/7033	455/7459
Compression ratio	8.5:1	8.2:1	8.0:1	8.0:1
Carburetion	One 4-bbl.	One 2-bbl.	One 4-bbl.	One 4-bbl.
Net hp @ rpm	175 @ 3800	175 @ 3600	201 @ 4400	250 @ 4000
Net torque @ rpm	270 @ 2400	305 @ 2400	322 @ 2600	370 @ 2800
Transmission	Automatic	Automatic	Automatic	Automatic
Axle ratio	2.73:1	2.71:1	2.75:1	3.08
Tire make	Uniroyal	Goodyear	Uniroyal	Goodyear
Tire type	Fastrak	Polyglas	Fastrak	Steelgard Radial
Tire size	G78-14	H78-14	H78-14	GR70-15
Steering	Power	Power	Power	Power
Overall ratio	18.2-14.8:1	18.8:1	21.73:1	17.5-14.2:1
Turns (lock to lock)	3.17	3.5	3.5	3.3
Turn diameter (ft.)	41.7	42.0	41.0	40.2
Brake system	Power	Power	Power	Power
Brake type	Disk/drum	Disk/drum	Disk/drum	Disk/drum
Disk diameter	11.0	10.84	10.72	11.0
Drum diameter	9.5	10.0	10.0	9.5
Swept area (sq. in)	332.4	365.2	361.0	337.3
Fuel tank (gal.)	22	19.5	22.5	25.0
Trunk space (cu. ft.)	15.6	16.5	14.8	15.1
Liftover height	21.4	27.0	29.1	21.5
Curb weight (lbs.)	4192	4013	4426	4659
F/R weight distribution (%)	57.3/42.7	57.6/42.4	60.1/39.9	58.8/41.2
Price (basic)	$3249	$3044	$2961	$4268
Price (as tested)	$4089	$4204	$4554	$5705

TEST RESULTS				
Acceleration 0-60 mph	14.45	9.75	10.3	8.75
Acceleration 0-80 mph	27.1	18.1	18.25	15.7
Acceleration 25-70 mph	16.25	10.75	12.2	9.35
Braking (cool) 60-0 mph	140.8	130	134.3	137.7
Pedal pressure	60 lbs.	90 lbs.	60 lbs.	80 lbs.
Braking (hot) 60-0 mph	172	148.3	157.8	153
Pedal pressure	180	200+	120	200+
Handling test (mph)	54.5	53.0	49.9	60.0
Maneuverability (mph)	24.6	25.0	22.1	26.0
Gas mileage 45 mph (mpg)	12.291	14.213	10.784	14.203

TEST CONDITIONS: Ambient temperature ..... 39° F
Humidity 66%
Barometric pressure ..... 30.6 inches

Mercury (top) has parking lights outboard of the dual headlamps. **Grand Am** (second from top) has single headlamps with parking lights at full width, below bumper. **Dodge** (second from bottom) has dual headlights framed in grille surround, with parking lights below bumper, widely spaced. **Buick** (bottom) has parking lights inboard of the single headlamps.

How other '73 cars have fared in our tests

TESTS	CHEVELLE LAGUNA	FORD GRAN TORINO	AMC MATADOR	PLYMOUTH SATELLITE SEBRING	AMC AMBASSADOR	CHEVROLET CAPRICE	FORD LTD	PLYMOUTH GRAN SEDAN	AMC HORNET	DODGE DART SPORT	MERCURY COMET	OLDSMOBILE OMEGA
Accel. 0-60	13.15	11.8	11.5	13.1	11.1	13.2	13.15	12.05	12.1	12.15	11.1	12.65
Accel. 0-80	22.6	21.55	21.0	23.95	21.7	27.55	25.85	21.8	21.3	22.4	21.95	24.15
Accel. 25-70	14.15	12.65	12.75	14.2	12.45	16.1	15.65	13.45	13.4	13.7	12.7	14.0
Brakes 60-0 (hot)	186.9	134.0	160.1	156.2	158.2	206.5	164.1	182.9	171.3	165.5	159.8	189.5
Handling (mph)	53.0	58.2	53.0	56.3	56.3	53.0	53.0	53.0	64.7	56.3	64.7	54.5
Maneuver. (mph)	25.3	23.9	23.9	22.1	25.3	24.6	25.3	23.3	26.0	23.9	27.2	25.3
Fuel (mpg 45 mph)	14.5	14.7	14.3	15.2	14.1	10.9	14.2	11.7	16.5	14.1	15.3	12.3
Noise (60 mph)	69dbA	68dbA	70dbA	70dbA	68dbA	64dbA	64dbA	66dbA	71dbA	71dbA	68dbA	70dbA
Price	$5126	$5070	$5060	$5107	$4776	$5017	$5236	$4939	$3365	$3139	$3311	$3607

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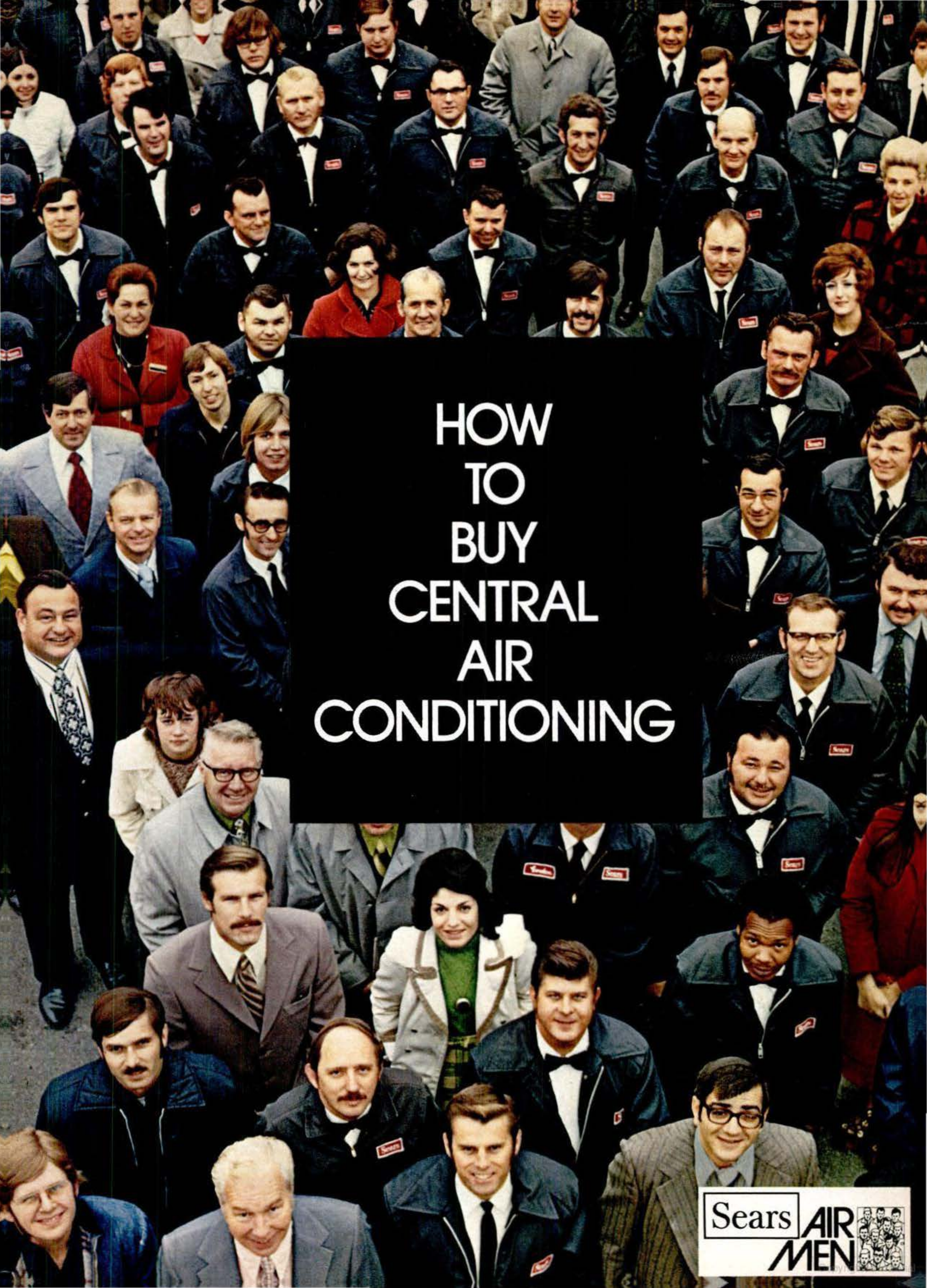
HOW TO BUY CENTRAL AIR CONDITIONING

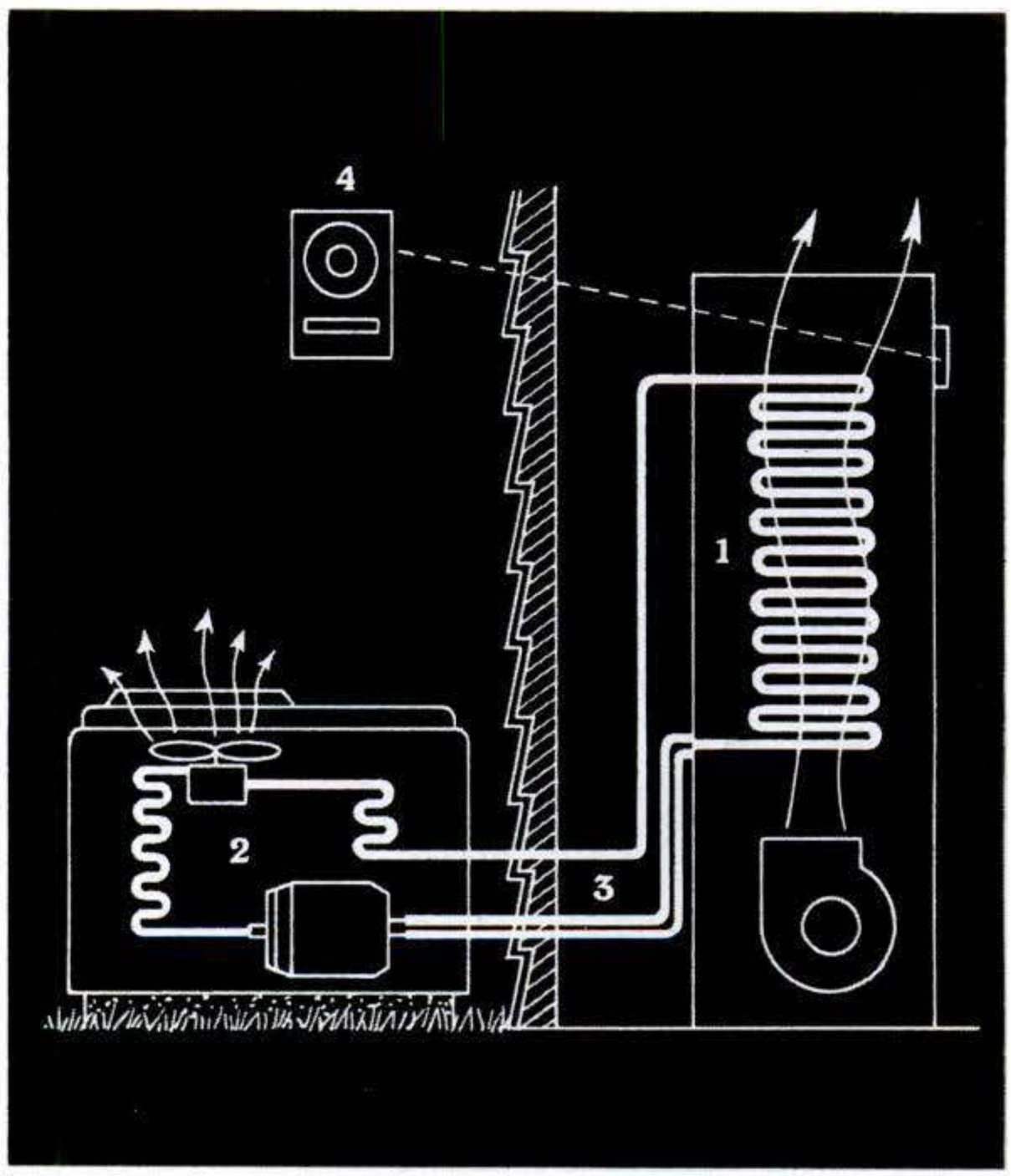


What is central air conditioning? How does it work?

It is simply a system of delivering cool, comfortable air throughout your house, not by adding cooling, but by removing heat and humidity.

With central air conditioning, the entire house is cooled to a more even temperature, with no sudden changes from room to room. So you get far more comfortable cooling than with window air conditioning, which is designed to cool primarily in the room where it is located.

A central air system is made up of four components:



1. Cooling Coil. Warm, moist air from your home is drawn through the duct work of your forced air heating system and circulated through the cooling coil on the furnace. The coil then removes the indoor heat and humidity.

2. Condensing Unit. Usually located on a slab or base outside the house, this unit pulls the heat from the inside of the house.

3. Refrigerant Tubing. This is the connecting tubing that transfers the heat, by means of refrigerant, from the cooling coil to the condensing unit.

4. Thermostat. This automatically controls the temperature level in the home. So you get more even, more comfortable cooling.

OK, I know what central air is, and I want it. How do I know what to buy?

You probably don't.

It takes a professional with specialized training to fit the right central air system into your house.

That's why Sears have the Air Men. They are a team of 10,000 professionals who can plan an efficient effective and economical central air system that's tailored to your needs, make sure it's installed right, and be there to give you service if you need it.

How do the Air Men decide what my needs are?

There are a lot of factors that go into the planning of a central air system. Probably more than you ever thought about.

You know that the size of your house is important. And your heating system has a lot to do with it. But you might not have thought about your windows. Or the type of home construction and insulation you have. Those things make a difference.

So does the direction your house faces . . . and the color of your roof. (A light colored roof reflects heat, a dark roof absorbs it.) The Sears Air Men know exactly what to look for when they come out.

Couldn't I just play it safe and order a big size unit to be sure I get the cooling I want?

It doesn't work that way. A unit that's too big is just as bad as a unit that's too small.

A central air system works by removing heat and humidity from the air. And the thermostat, which only measures temperature, not humidity, shuts the unit off as soon as the desired temperature has been reached.

A system that's too big will lower the temperature very quickly, but *before* the proper humidity level has been reached. So your house will be cool, but you'll still be uncomfortable.

The Sears Air Men can assure you a system that's not too big or too small, but just right for your home.

Can central air be installed with any heating system?

Yes. Normally, central air is installed with a forced

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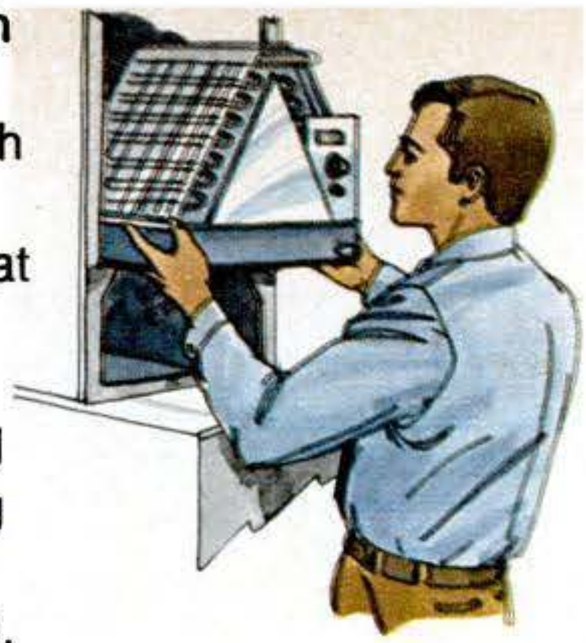
air heating system. But with the addition of duct work, central air can be used with any heating system. However, don't assume that because you have a good heating system, it will convert naturally to a good central air system. Cooling generally requires more air movement than heating.



In order to plan a central air system, the Sears Air Men will make a complete examination of your heating plant. They'll find the load your electrical system can handle, the size and location of ducts and registers, the adequacy of your furnace, the blower capacity. (If your furnace is putting on years and needs replacing, you can save some money by having it done at the same time your central air system is installed.)

After he's made the complete examination, your Sears Air Man can tell you which size central air conditioning system will provide you with the best cooling.

THE SEARS AIR MEN ANSWER YOUR QUESTIONS ABOUT CENTRAL AIR CONDITIONING

Will central air conditioning be expensive?

Your needs will determine the cost.

But good planning, the kind you get from the Sears Air Men, can keep you from spending more money than you need to . . . not only in the cost of the system, but in the cost of operating the system.

Sears Air Men have convinced me that central air conditioning is what I want.

But why should I buy air conditioning from a department store?

There are four basic considerations in buying cental air conditioning:

1. Equipment. Let's face it, most central air conditioning systems are designed to do the same job. Cool your house.

So if you buy from a reliable dealer, you'll probably get satisfactory cooling. But Sears wanted more than just satisfactory cooling. So Sears air conditioning systems are designed to give you operating efficiency and operating economy. The "High Efficiency" line also cuts operating noise.

2. Price. What's really important about price is not what the system costs, but what you get for your money.

Four elements make up the cost of central air: cost of equipment, installation, operating cost, and service.

The Sears Air Men are trained to give you an effective and efficient system at an economical cost. They won't sell you a system that's too small just to save you money.

And they won't sell you a system that's too big just to make a few extra bucks. They'll plan a system that's just right for you.

3. Service. If something goes wrong with your central air system, you don't want to wait until October for a service man.

The Sears Air Men are only a phone call away. So when you need help, they can get to you fast.

4. Guarantee. The Sears Men have Air Assurance. It's a five year guarantee that promises to repair any part found defective the first year. For the next four years the Air Men will replace the compressor if found defective . . . at no cost to you for parts or labor.

Come in and let the Air Men show you how this guarantee stacks up against the others.

Call the Sears Air Men today for a free home estimate. Let them show you how easy and inexpensive Sears central air conditioning can be.

SAVE THIS GUIDE FOR A HANDY REFERENCE WHEN SHOPPING FOR CENTRAL AIR CONDITIONING.

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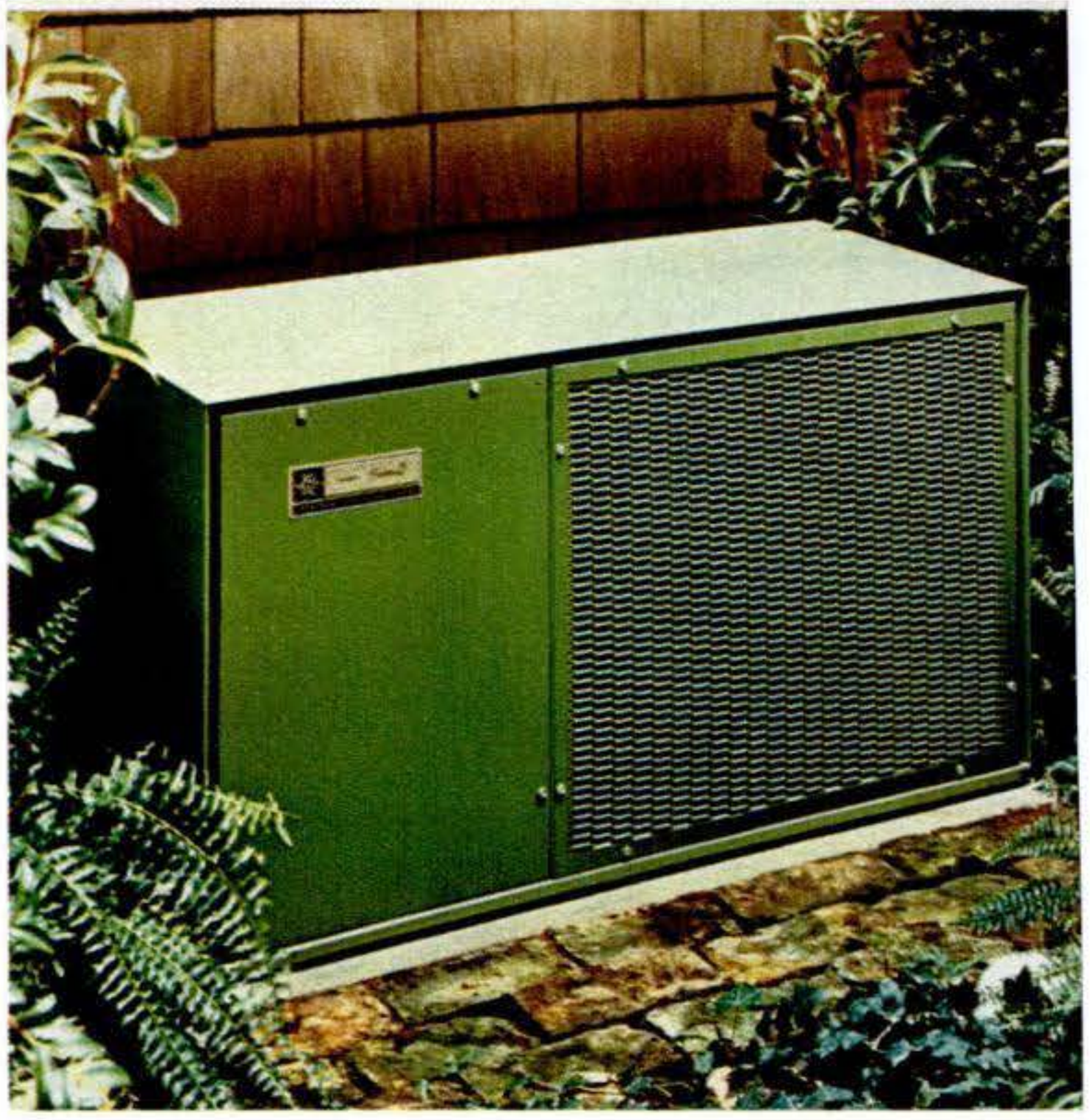
HERE ARE THE TWO MAJOR CENTRAL AIR SYSTEMS AVAILABLE FROM THE SEARS AIR MEN.



Sears High Efficiency Series
Sears "High Efficiency" central air conditioning is Sears best system. Features include solid state modulating control, top air discharge for quiet, thrifty operation and reliable service.

The new modulating control automatically selects condensing unit fan speed for low sound level plus maximum cooling efficiency. The fan works only as hard as it has to. The higher the temperature outside, the harder it works. When the temperature goes down, the fan is slowed to give you the quietest operation possible.

Modern design High Efficiency units are available in capacities to meet most home needs.

Sears New "Custom II". The new Custom II was designed to give you 15% greater operating efficiency than last year's model. But it's still an economical choice for dependable, fast home cooling. Rust-resistant cabinet is bonderized and finished inside and out with tough acrylic enamel.

And we've added a 2-speed control that adjusts the fan speed to give you quieter operation than last year's model.

It uses quick-connect fittings that are hermetically sealed until joined at installation; units are charged with refrigerant at the factory for easy, economical installation.

Ask about Sears convenient credit plans.

You'll find all types of residential air conditioning at Sears. Whether it's a 6,000 BTU Modular unit or a 55,000 BTU central air conditioning unit, Sears has it. And Sears has one more thing, The Sears Air Men.

Call or mail this coupon to the Sears Air Men at your local Sears store for a *free* home estimate.

Please have the Sears Air Men contact me for a *free* home estimate on central air conditioning for my home.

Sears AIR MEN

NAME _____

STREET _____ PHONE _____

CITY _____ STATE _____ ZIP _____

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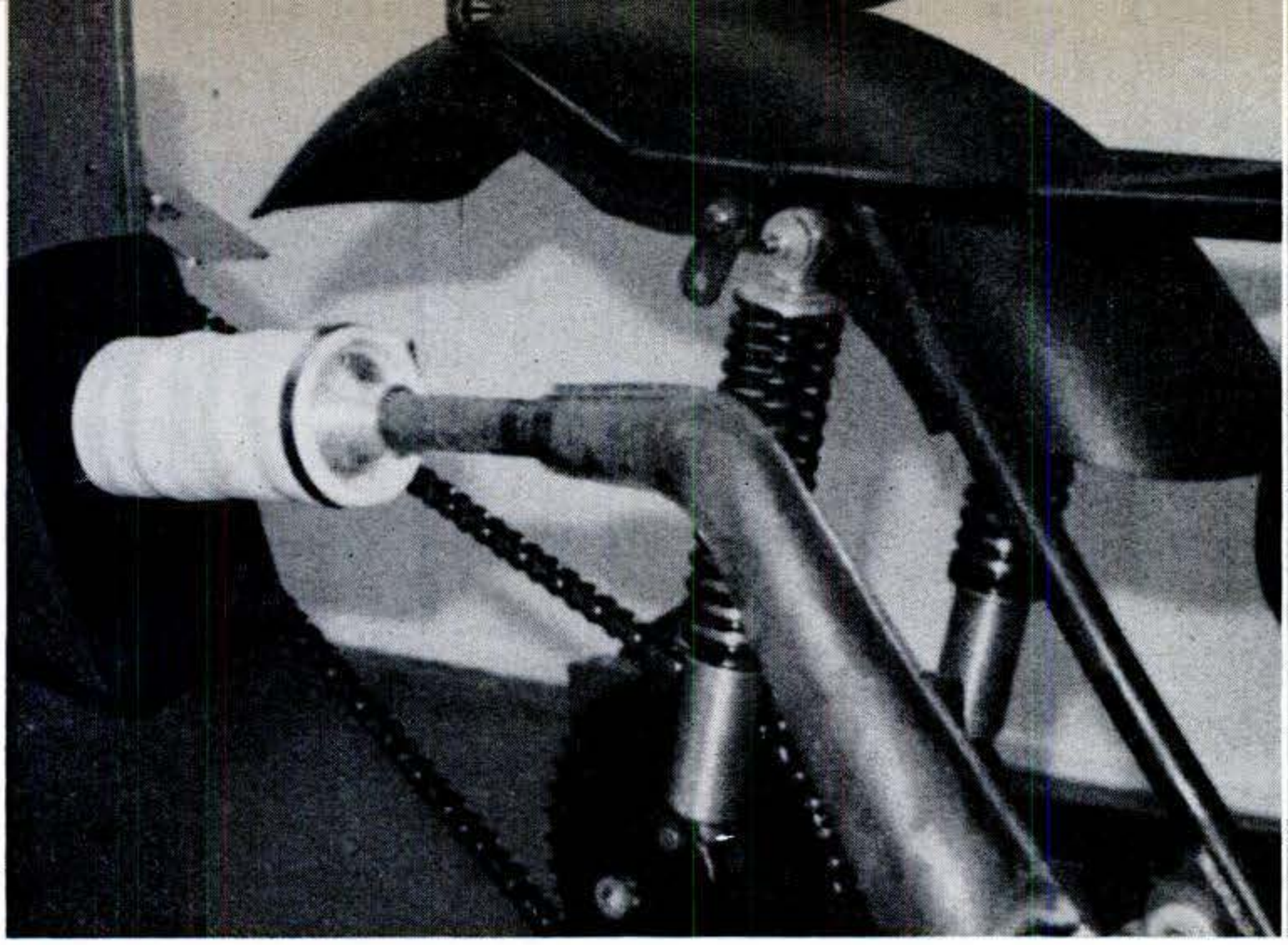
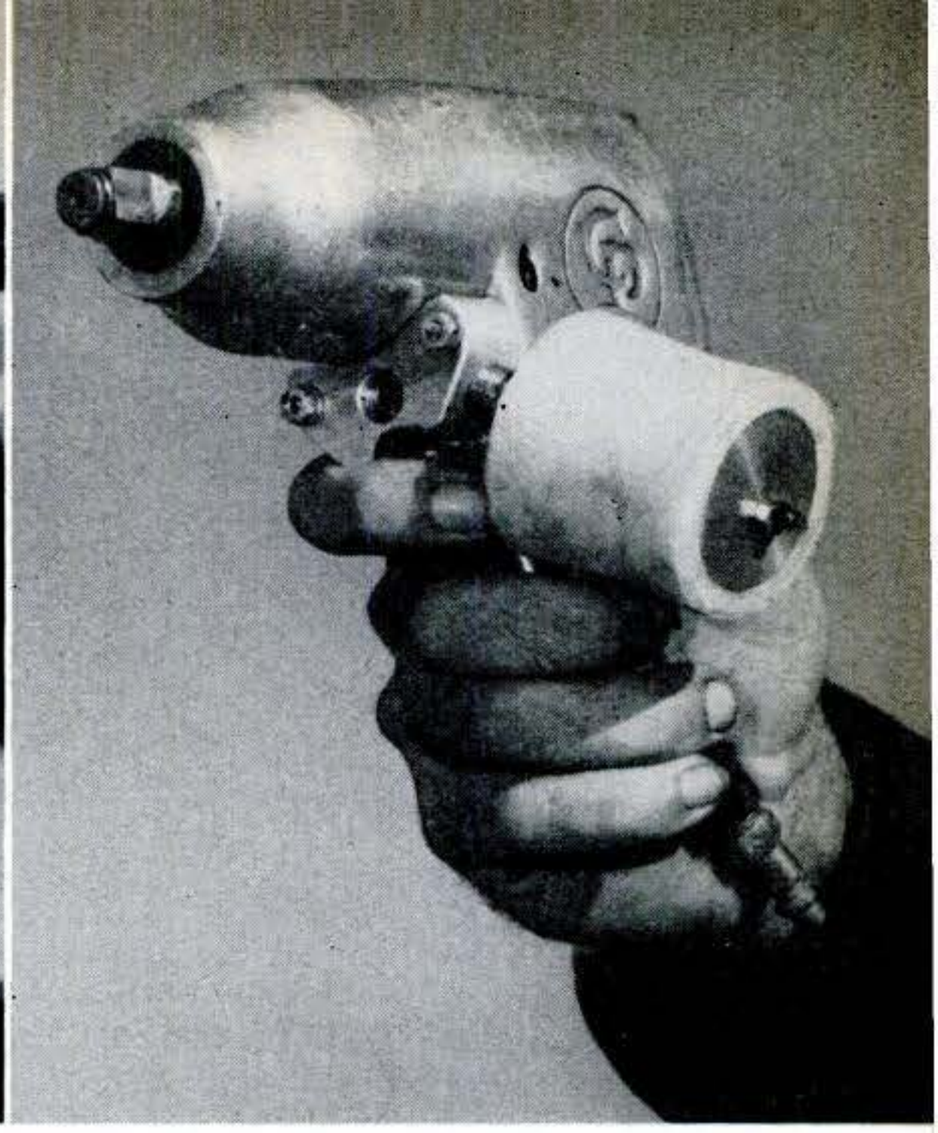


Round silicone muffler on end of this wheelless motorcycle's exhaust pipe is undergoing test with a dynamometer. Muffler slips over exhaust pipe, is held secure with clamp.



That white cylinder sticking out from impact wrench is a prototype muffler. In production models, muffler would be built inside the body of the wrench and would protrude less.

Silicone Muffler Puts the Hush on Noisy Engines and Pneumatic Tools

It's soft and it pulsates, providing up to 90 percent reduction in noise output

By JIM DAVIS

"I can't hear any exhaust noise," I said, as I pressed my ear against the silicone muffler.

Moments earlier the portable generator's unmuffled two-cycle engine had been emitting an ear-splitting 111 decibels of sound. Then the silicone muffler was attached and the generator's screaming exhaust noise vanished. Now I could hear the quiet mechanical sounds of the engine running. The generator belonged to inventor Mike Murphy, who was demonstrating for me what his latest invention, the Murphy Muffler, can do.

The muffler is made of a resilient silicone-rubber outer body housing a twin-chambered metal frame. As exhaust gases enter the primary chamber they expand the rubber outer body, making it relax its grip on the baffle separating the two chambers. Gases slip past the baffle into the secondary chamber, then exit the muffler. Expanding and contracting in synchronization with the engine exhaust, the pulsating silicone absorbs a large proportion of the high-frequency sound waves created by a loud two-cycle engine.

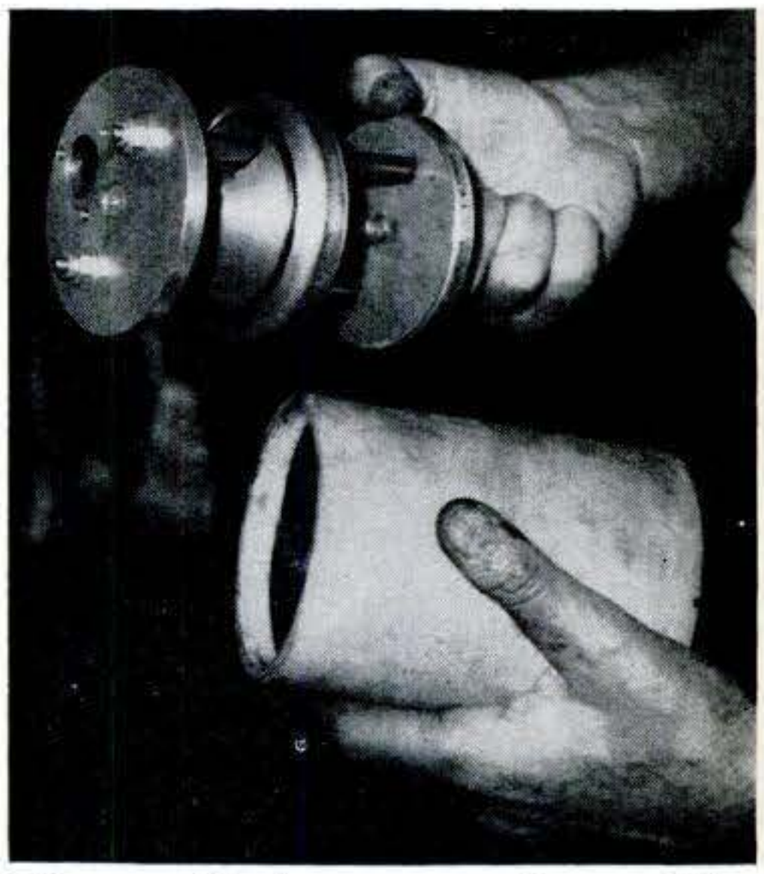
In addition to decreasing exhaust noise, the muffler can increase performance. Engineers testing motorcycle engines on dynamometers have noted substantial gains in rpm, power, and power-band ranges of two-stroke powerplants.

Quiet pneumatic tools? High-level noise from pneumatic tools can be greatly reduced by the silicone muffler. An impact wrench tested without a muffler emitted 103 decibels of sound and had a torque of 160 ft.-lb. With a silicone muffler attached where air is exhausted, noise level was reduced to 82 decibels, torque increased to 167½ ft.-lb. Murphy hopes to sell manufacturing rights to pneumatic equipment makers so that future pneumatic tools will be equipped with silicone mufflers.

If you're a model-airplane buff, using the Murphy Muffler will decrease your engine's noise level 90 percent, and allow use of a 22-percent bigger prop—effectively increasing horsepower. Two sizes are available: Maxi and Mini. One or the other fits any model-airplane engine. The Maxi is $13; the Mini, $12.

Mufflers for all two-cycle motorcycle engines up to 400cc will soon be available for $30. From Murphy Muffler Co., 5312 East Beverly Blvd., Los Angeles, Calif. 90022. PS

Noise-level meter, left, measures the sound output of impact wrench, right, after silicone muffler is installed.



Disassembled motorcycle muffler shows metal frame and tubular silicone outer body. Silicone is Silastic 35U from Dow Corning—extremely heat resistant.

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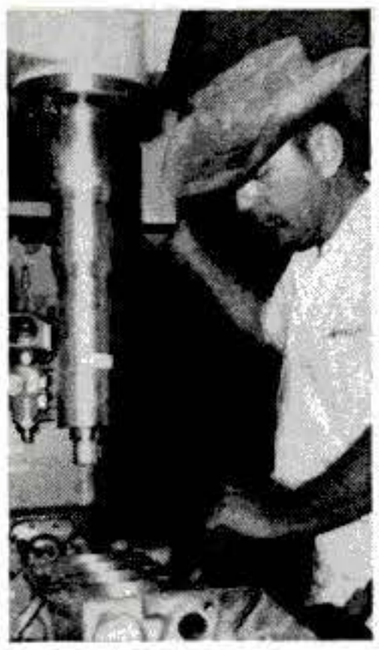

"Say, Smokey-"

A clinic on cars by America's most famous mechanic

Each month in *Popular Science* Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—" Popular Science, 355 Lexington Ave., New York, N.Y. 10017. Questions cannot be answered by mail.

Where honor's due

Why is it that my 1965 Cadillac has gone over 220,000 miles without the head ever having to be removed? Compression is 170-175 pounds per cylinder. The transmission has required no attention. And the steering is perfect except for a slight moan. Brakes weren't relined until 148,000 miles, and the drums were perfect then and show no signs of wear now. Tires were replaced every 30,000-35,000 miles. All I did was follow the instructions on servicing!

LAWRENCE B. WHIT, Weston, Conn.

There's a first time for everything, I guess, and this is my first "on-the-positive-side" question. It's been years since I've heard anything good about our cars. It looks like you could be a candidate for the driver-of-the-year award if they would only have one. You and your car are tangible proof that if one drives sensibly and performs the proper preventive maintenance on a car, he'll make out very well indeed. Also, it appears that the Cadillac engineers spent a few days around the engineering department.

Pickup gear ratios

I will be returning to the states in 1973, living in a northern Michigan community on fixed income, and would like your advice on specifications in a Ford half-ton pickup truck. I will be using it for light hauling and general transportation, and eventually will install a cab-height, windowed shell. The shell will be a lightweight commercial-type covering for the truck bed, giving me shelter for some sleeping-bag campouts. My choice is the eight cylinder F-100, eight-foot bed with automatic transmission. But I am concerned about choosing the correct gear ratios to go with either the 302 or 360 engine, so I'll get the best gas mileage without loss of performance for my particular needs. Also, which engine and carburetor is best for me —the 302 or 360?

V. K. LIGHTY, FPO, New York

Sounds like you've been away for a long time—good gas mileage has long since left. With temporary patches to hold the fort on pollution until a real fix is worked out, we have strangled our engines so you'll need to go the big engine route to get enough power to run legal road speeds. Your gear-ratio selection is tied in with the tire diameter you choose, so it isn't possible to say, for example, when to order 3.2:1 ratio. Ford has a chart for gear selection that considers the engine and its torque characteristics, transmission gear combination, and different tire O.D. offered. You'll be living in low-altitude, fairly flat country with average or above-average roads, but will have medium to light-heavy loads, so I would suggest that you stick in the middle gear ratio. That is, if you have an option from 3:1 to 3.6:1, go for something about 3.3:1. As to which carb and engine, I believe the 360 with the four-barrel carburetor would satisfy you, and I'll go along with you on your transmission and wheelbase choice.

Scraping bottom

I bought a real 'road-grader.' If I have four people in my 1971 Chevelle and there's a rock as big as your fist on the road it scrapes the bottom of the car. On the same road my VW never gave it a thought. Is there any way to increase road clearance on this car?

PAUL W. STALLINGS, Conway, Ark.

There are two ways to increase clearance that are the most simple and obvious: install bigger tires, or heavier springs. I suspect the springs are your best answer. The cheapest and most effective way would be to replace your springs with H/D springs and have the front end realigned.

Go to a 4-bbl. carb?

I've got a '67 Camaro with a 327 V8 engine. Would installing a four-barrel carburetor improve performance? If so, would it be necessary to get a new manifold, or do these dual-to-quad carburetor adapters work all right?

RICHARD HAILEY, Dallas, Tex.

A four-barrel put on right would help the top-end performance, but not the low-end—in fact, it might cut it a dab. You have to put on the correct four-barrel manifold—the adapter deal you mention is mickey mouse, at best.

Rebuilt with hard knocks

On my dealer's recommendation, after 127,000 miles on my 1966 Chrysler New Yorker, I installed a rebuilt short-block engine with a valve job and new valve springs, carburetor overhaul, and tuneup. I broke it in at the recommended speeds of 45 mph the first 500, under 55 the second 500, and up to 65 mph the third 500 miles. I have now driven more than 6000 miles with good power and gas mileage and very low 10/30 oil consumption.

When the engine is started cold it's so noisy that I'm almost afraid to drive it. It's been that way since it was installed, and even at fast idle it is quieter; but when I put the transmission in drive and step on the gas, it is terribly loud. Sounds like a combination of hard spark knocks, loud wrist pins and tappets knocking, and piston slaps. In less than a mile of slow driving the engine quiets down considerably, and after three or four miles I can detect only a small power knock under 45 mph. At highway speeds it is quiet. What can I do? I am really upset.

R. R. PEARSON, Pasadena, Calif.

I doubt if you'll ever be happy with this engine. It is probably set up much looser than your other one, and you are correct—you are hearing pistons, wrist pins and rods jumping around until they get hot and expand some. Rebuilt engines done in mass production are great—in reference to cost. But our luck with them as a whole has been horrible. In other words, this is a good idea that isn't working out because of the growing disease of workers called That's Good Enough, complicated by the manager's disease of Costitus. These wipe out craftsmanship and customer satisfaction.

Training for a mechanic

I'm preparing to get out of the service and want to work as a mechanic. Would you recommend a correspondence course, or say Denver Auto and Diesel College? The price difference is considerable, but I want the best background preparation for two reasons. One, knowledge that I'll be able to do the job right. And two, I won't be laughed out of the shop when I go asking for a job.

OLIN HARDY, Strasburg, Colo.

Without any reservation I would recommend the personal-attendance courses. As desperate as the automotive industry is for talented and knowledgeable people, the big problem facing the potential employer as he interviews the applicant is, "Will he stay and let me recover the investment necessary to train a real mechanic?" I know of no better way to show your serious interest than

Continued

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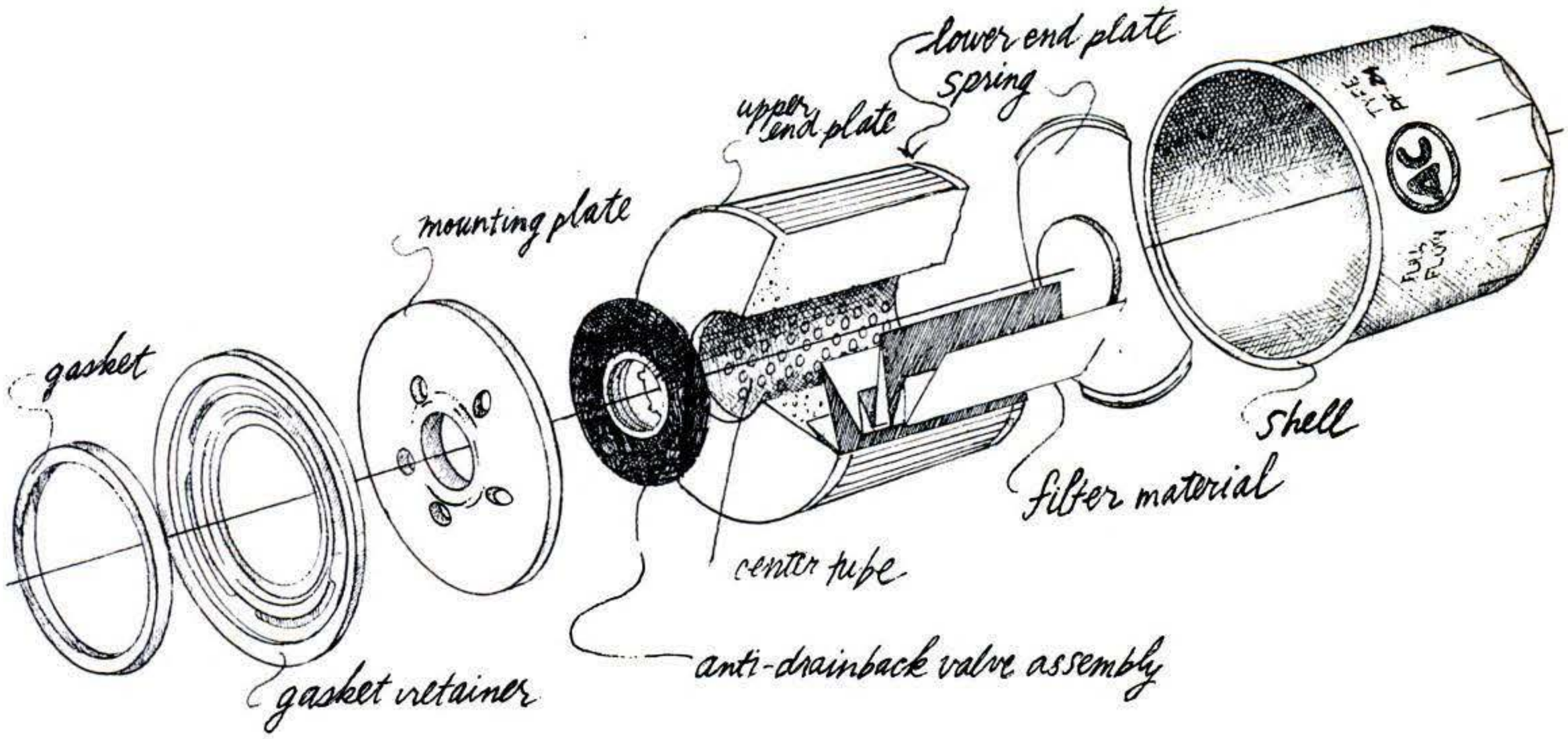
TOUGH!



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FILTER MATERIAL—resin-impregnated, polyester-reinforced filtering media helps provide reliable protection. AC's "W-Fold" design provides a large filtering surface area.

SHELL—a heavy-gauge steel enclosure . . . features a "15 flat" design for easy removal.

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AC keeps you going when the going's tough

AC SPARK PLUG DIVISION

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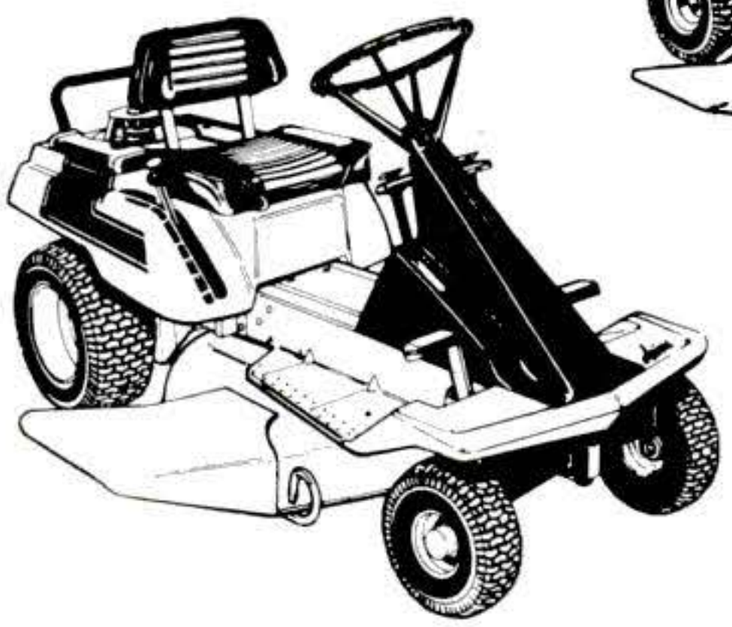
TAKE YOUR PICK... AND YOU'LL PICK A WINNER!



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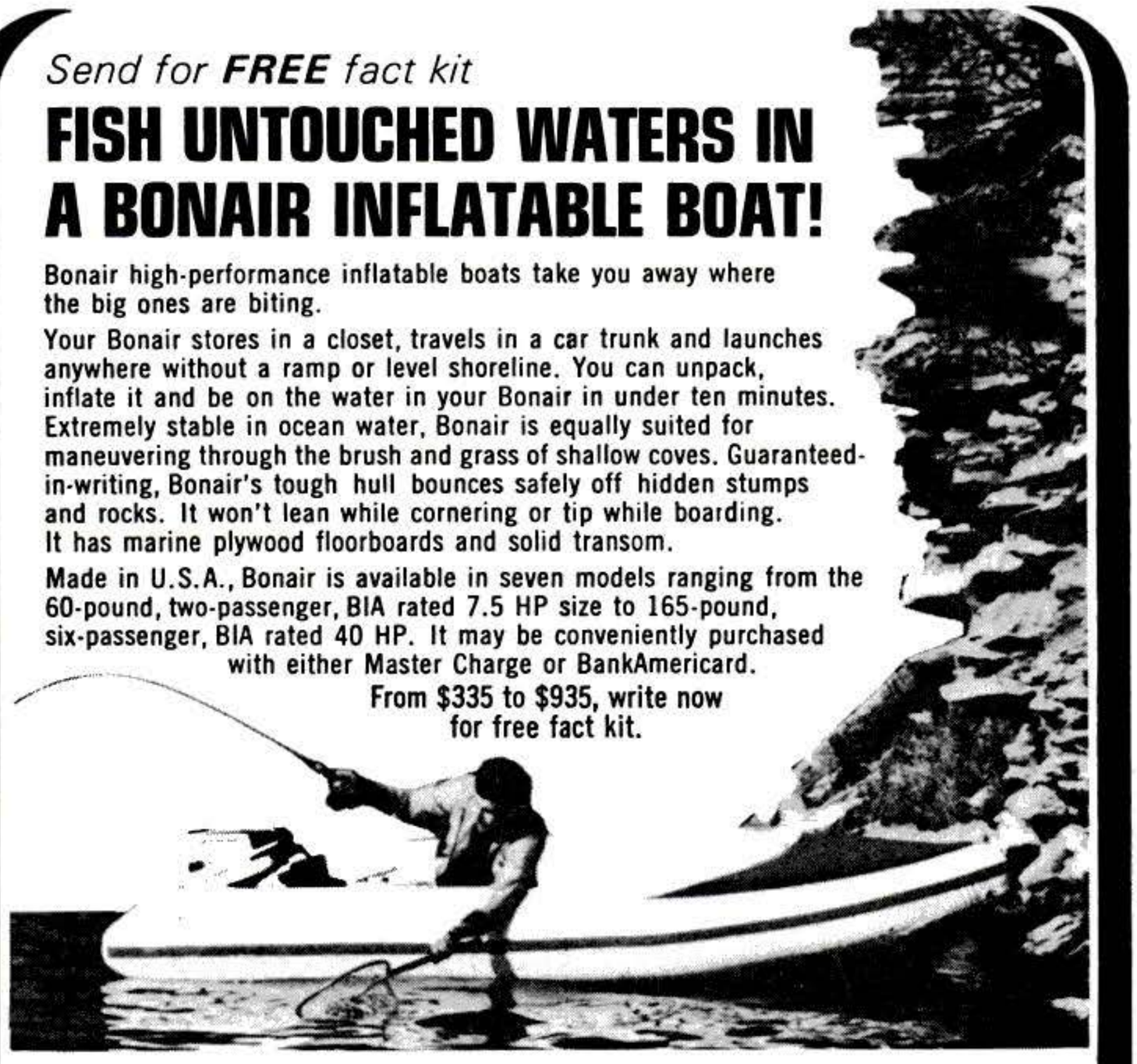

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Write to Dept. PS-5

"Say, Smokey—"

[*Continued*]

by presenting a diploma from a good school you attended.

Won't stop pinging

My 1971 Maverick six 200-c.i.d. engine won't stop pinging. It has new plugs, points, and condenser. The specs call for initial timing at six degrees BTDC and I retarded the timing to four degrees BTDC, but the engine still pings. The car has 17,500 miles on it. Is there anything else I can do, or do I have to use premium gasoline? The manual calls for regular. Please help.

AUGUSTA DA SILVA, Bronx, N.Y.

Pull the cylinder head, clean the carbon, and check the combustion chamber for sharp edges that could be hot spots. Check the compression ratio—is it too high? How to do all this would take three or four pages, but it's important. A good mechanic or parts man should be able to nail that down. In reference to the correct head, gasket, and piston combination, assuming no trouble here, move to the distributor. Check the advance and advance curve; verify that the timing mark is correct in reference to top dead center. Also have the air-fuel ratio checked—it could be too lean. Your Maverick should run fine on regular gas.

Temperature running high

My car is a Monte Carlo '71 Vintage SS 454. Whenever I get stuck in traffic or stop for a short time in warm weather, the temperature gauge rises to 250 degrees. As long as I keep moving, it reads 195 to 210 degrees. The radiator has never boiled over yet, but it's giving me gray hair. I changed the thermostat, flushed the radiator, checked the fan-belt tension. With the air conditioner running in summer I have to avoid all traffic jams—which is impossible in New York. I checked the gauge for accuracy. It also reached these temperatures after a stopdown on the expressway in winter. Is there an answer to this?

LLOYD BARRY, New Hyde Park, N.Y.

Since you checked the gauge for accuracy, then those temperatures are bonafide, and too high. I'm afraid your problem is that there is simply not enough radiator for so big an engine and an air conditioner in hot-weather traffic jams.

Now, at idle and slow speeds the fan is all-important, so maybe you can increase cooling here and get out of trouble. When an engine shuts down, the temperature will rise before it goes back down. This is caused by heat soaking into the water with no circulation of air or water. I think I should mention that late ignition timing or a lean carburetor will also cause excessive water temperature, even if the cooling system is adequate.

Continued

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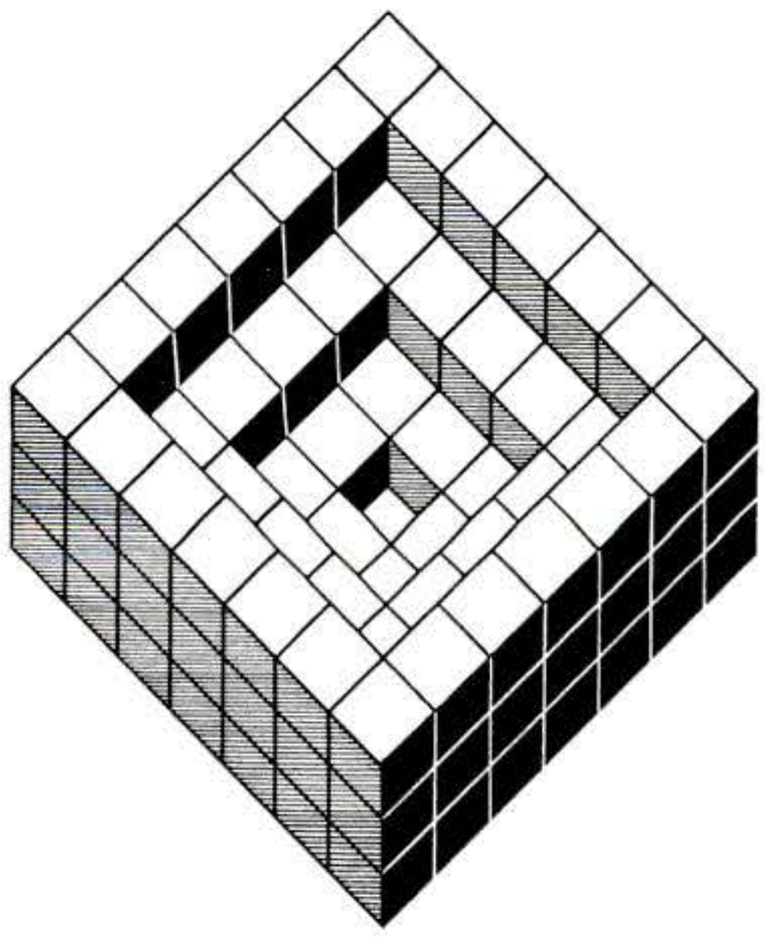
Want a job doing what comes naturally? Take this test.

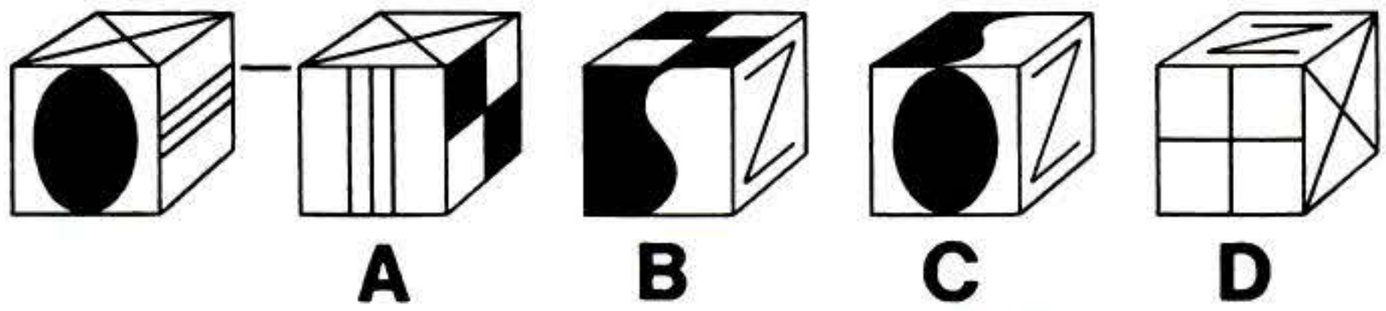
Think you're a "natural" technician? Then you should be a lot better than average at spotting the differences between similar objects. For example, which part, A, B, C, D, or E has a visible defect?

Answer: D



Here's a tougher one. Give us the right total of cubes in this figure. You'll be proving to yourself you have the kind of clear head and mechanical aptitude that really count for something in the Air Force.

Answer: 112



Good imagination and deductive powers? They'll help you fly through the Air Force's many types of advanced technical training. Think—which ones of cubes A, B, C, or D could be the same cube as the one on the left, only turned?

Answer: A, B, C, D

Illustrations Courtesy of Arco Publishing Co., Inc.

Got them right? Then you might rack up high scores on the Air Force Aptitude Test. And that could do you a lot of good. Now, by qualifying you for outstanding technical training in one of over 100 Air Force jobs, from aircraft mechanic to medical specialist. And later, when you offer prospective employers a reusable skill.

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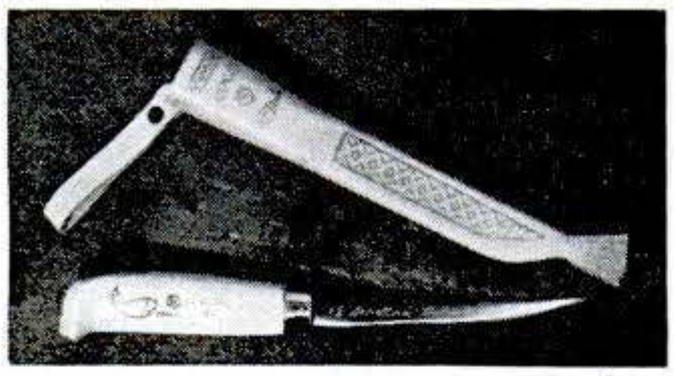
New. Specially designed Rapala Fish 'N Fillet Knife with four-inch stainless blade. Ideal for trout and panfish.

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"Say, Smokey—"

[*Continued*]

A hesitation problem

Recently I purchased a 1969 Chrysler Newport which I like, but it has one problem I haven't been able to solve. It hesitates when I accelerate either slowly or moderately fast. Sometimes it will cough and then take off. Occasionally it will just die, as if the fuel were shut off. After driving 10 or 15 minutes the engine is completely warmed up and the hesitation disappears. The car came with a two-barrel Carter BBD-4614S which I replaced with a later-recommended Carter BBD-6134-1432. This carburetor has two idle-mixture screws, whereas the old carb had only one. The new one also required a choke-modification kit. The work was done by a local carb shop. The car has new plugs and points; vacuum and centrifugal advance both operate properly, manifold heat valve is okay, automatic choke is set to specs and operates okay, the timing is set to 7½ BTDC, and compression is within 15 pounds on all cylinders. What now?

JOHN WRIGHT,
Cedar Rapids, Iowa

First check the accelerator pump shot for amount and timing; that could be the whole deal. Your trouble is lean on idle and dead lean at off-idle, so cut down on air or increase the fuel flow at these points and the car will run as it should. How to do this could fill 10 pages if your carb is on specs now. So your mechanic will have to do some reading and playing. One other thing: Be sure the ignition advance is doing its thing, that it's not retarding when you tip in to the throttle.

Hard to start, no go-power

The compression is poor in my '68 Mercedes 200-D—at only 58,000 miles. It is hard to start and lacks go-power. Would driving this four-cylinder at highway speeds add enough to cylinder wear to cause the problem? What are other weaknesses of this model?

BOB NORMAN, Delta, B.C.

If the compression is bad, you'll have poor start and go. I don't know why that car got into this predicament so soon, since that engine is quite well built and would usually have a long life. Hard driving shouldn't bother it. I'd suggest that you double-check the type of oil you use to see if it's correct for that engine. Also make sure the air cleaner is working properly. Check on the fuel mixtures: Over-rich fuel will wash the cylinders, increasing wear and creating a sticking ring condition; over-lean will increase ring scuffing and galling from excessive cylinder temperatures. PS

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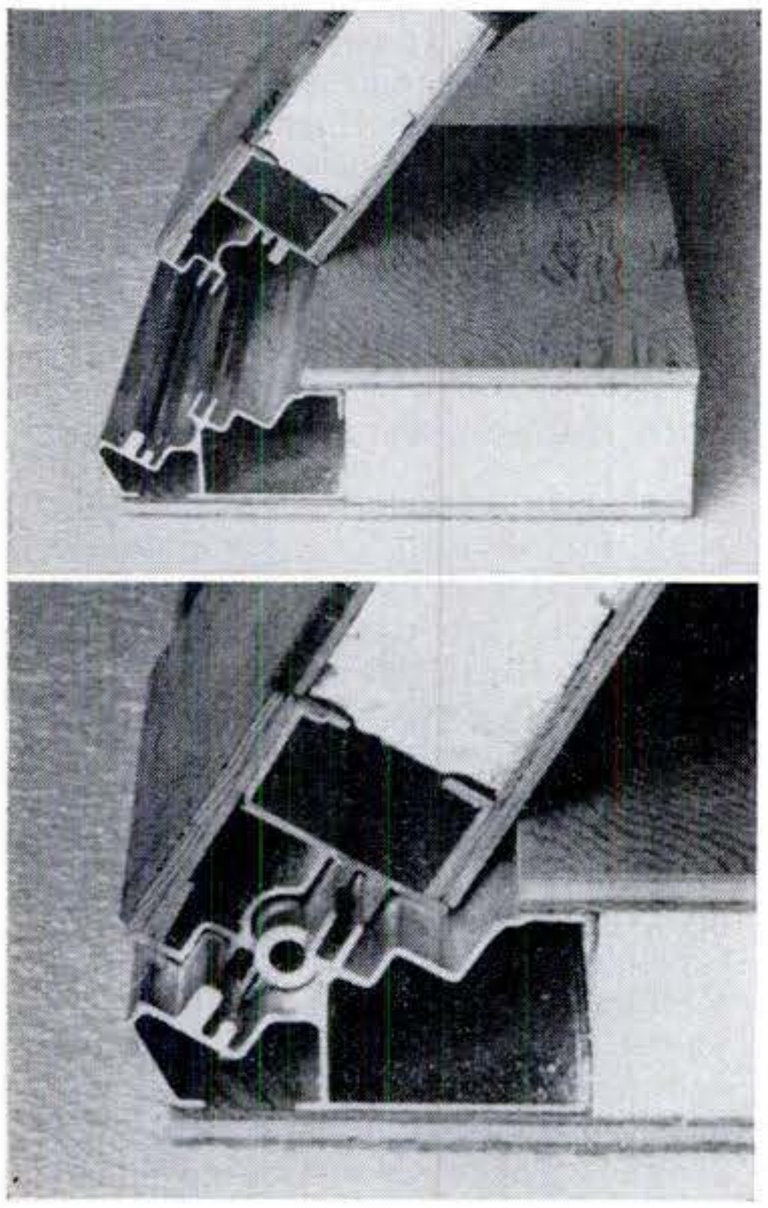
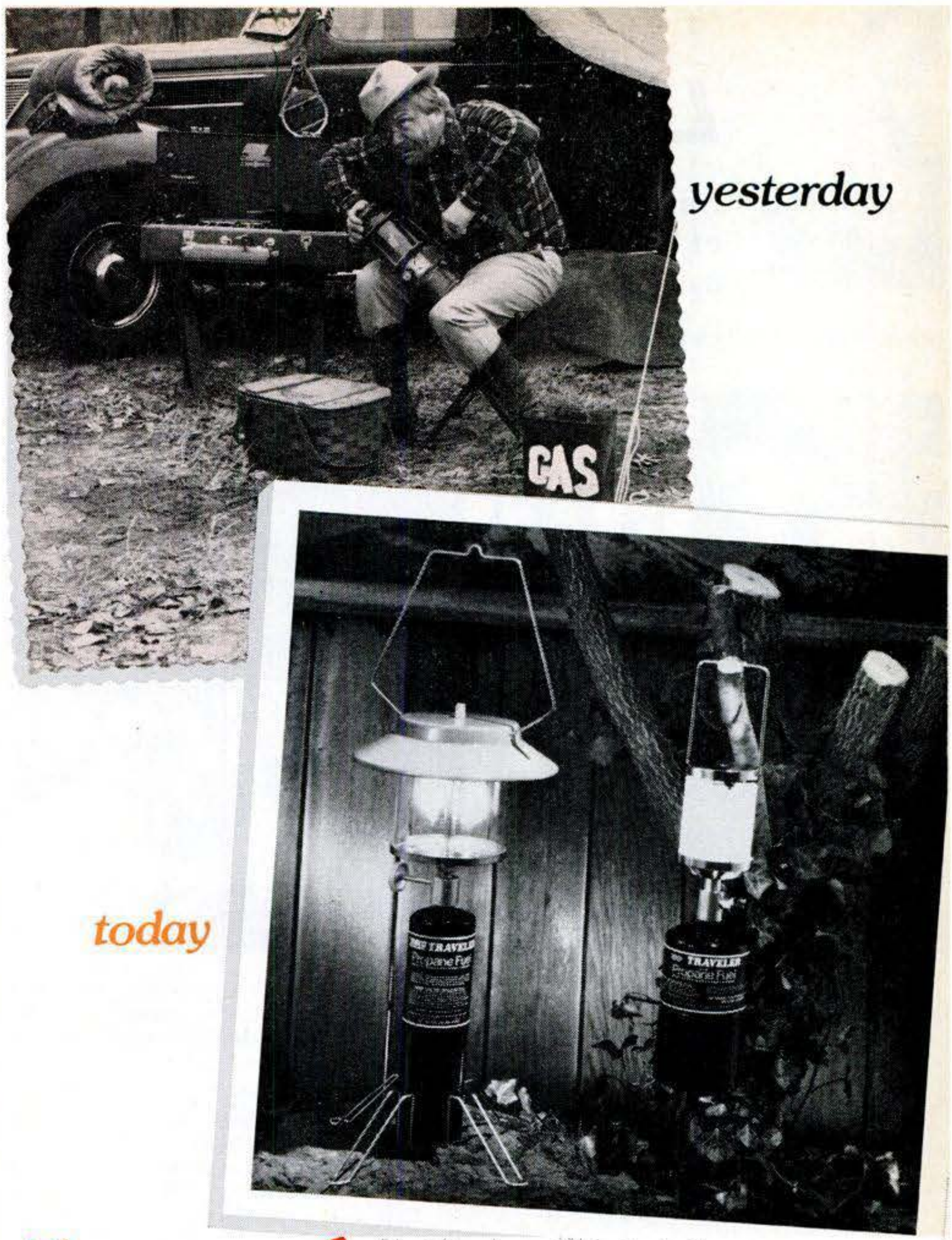
Basic 16-by-32-foot lodge can be expanded with add-on 4-by-16 sections. Upper window is kid-proof acrylic.

Vacation Lodge You Put Up in a Weekend

A weekend's work (with the help of friends) and $5295 give you this 16-by-32-foot A-frame vacation lodge. The exterior is rough-sawn Texture 111 siding; the interior is white vinyl; and there's two inches of foam insulation between. Standard features: a sleeping-loft balcony, closets, sliding front door, and front deck. Options: kitchen unit ($332), 12/110-volt wiring harness ($104), portable toilet ($109), demand water system ($53). North Lodge is made by R-J Industries, Box 237, Readlyn, Iowa 50668.—*E. H. Ortner.*



Ingenious panel joint is locked by pin. Vinyl cap outside seals out weather. Disassembly is as simple as assembly.



times change

For years, nothing could beat the gasoline-fueled lantern for portable outdoor light, because for years gasoline was the only practical fuel available. Campers learned to live with the smoke and soot, and the irritation of continual pumping.

That's in the past.

Today there's a new fuel in the picture – *propane* – the perfect fuel for modern camping. And there's Traveler by Zebco – outshining all others in outdoor light! The double-mantle design of the Traveler 300 Lantern by Zebco achieves a brightness near that of a 300 watt bulb, making it ideal for lighting large areas, indoors and out. The single-mantle Traveler Starlight is a brilliant innovation in style and versatility. Both lanterns can be fueled from disposable propane cylinders for portable use, or fueled from a bulk tank as pole lights or hanging lights. Clean-burning propane produces no odor, no smoke to blacken globes and mantles. And there's no pumping – both lights give you hours of "flickerless" performance and are fully adjustable from soft light to full brilliance.

See the Traveler 300 and Traveler Starlight Propane Lanterns at your camping products dealer. And see the complete line of outstanding Traveler by Zebco propane appliances – stoves, heaters, lights – made for camping *today*!

Times change. The good times get better with Traveler by Zebco!

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Look and Listen

News, comment, and opinion from the world of home-entertainment electronics

By C. P. GILMORE

Pay your money, take your choice

Remember those battles over broadcast pay TV? Well, they're over. Now, with more and more TV sets across the country hooked into cable systems, the argument is out of date—you can have free *broadcast* TV, and get special programs you pay for over the cable.

Companies are rushing to get the equipment ready. For example, Magnavox and TelePrompTer (the latter is big in the cable-TV business) recently demonstrated a slick new system called Premium TV that TelePrompTer will be trying out in some yet unnamed California city this spring. The young lady in the picture above punches a button to see what's playing on two special cable channels. The circuits in the unit outside (upper right) give her a quick preview peek at the special attractions. If she wants to keep watching, she pushes an "accept" button. The unscrambling circuits then decode the program she's selected—perhaps a new movie or a championship fight—and route it to her set (each outside line unit handles up to 32 homes). At the same time, a memory in the device notes which program she bought.

Once a month the friendly meter reader (lower right) plugs a standard low-cost tape recorder into the box at the bottom of the telephone pole. The box reads out in digital form all of the information about who bought what during the month. This is played back into a central computer, which automatically bills everybody for the programs they have seen. With the coming of two-way TV the meter reader won't be needed; the unscrambling device on the telephone pole will automatically signal the computer every time somebody buys a program.

Advocates of pay TV have argued that allowing viewers to pay for programs they specifically want will encourage production of a much wider range of program material. You could have special-interest programs not designed to attract the largest possible number of viewers. With a box office in the house, you could also show new movies and other big-ticket items on the home screen.

The idea never got off the ground because of the severe limit on channels available. Now, with cable piping large numbers of channels into everyone's house, there's no reason that pay TV shouldn't get a chance. If paying customers like it, it will survive. If not, it will go the way of other ideas that sounded good but didn't make it when the customer had to put his dollar on the line.

Finally, something's cheaper

That business about solid-state TV sets being more trouble-free—now there's real evidence to back it up. Sears has directed all of its service units to charge $5 less for maintenance contracts on solid-state than on conventional sets. RCA has cut the price of a two-year contract on its XL-100 by $20 while the contract for standard hybrid sets remains the same. Scattered reports from around the country confirm that service dealers find solid-state sets need less maintenance. No surprise it's showing up in service-contract prices.

Briefly noted

- Yet another entrant in the video-disc race: Syndor-Barent-Scanner of Albuquerque, N. M., uses an optical system with a transparent disc containing thousands of minute lenses and an equal number of tiny photographic images to produce a reportedly flicker-free picture at 12 frames a second. Records will have 90-minute black-and-white playing time or 45 minutes in color, cost about 25 cents to produce. The company says the machine will be cheap.
- Video-disc systems shown by MCA [L & L, March '70] and Philips ["Laser Plays 45-Minute Video Disc Through Your Color TV," PS, Dec. '72] are reported to be very similar. Now industry rumor says the two companies are negotiating to find a standardization agreement. Obviously if they gang up on the rest of the industry, they'd have a better chance of having their system become the standard.
- The cartridge videotape recorder field has narrowed a bit. The Ampex Instavideo system, long dormant, is now officially dead.
- The RCA Selectavision VTR system got another boost recently. Electrahome, Canada's big independent color-TV manufacturer, has decided to use the RCA system. First units should be on the market by May '74.
- If you're new to tape recording, you might enjoy a nifty booklet called "Recording Basics" from the 3M Company. It covers the nature of sound, magnetic recording and how it works, tape formats in common use, how to use and maintain your tape recorder, splicing and editing, and so on. It's free at 3M tape dealers or Dept. Ma 3-8, Box 36600, St. Paul, Minn. 55133.

Record reviews by Arthur Fisher

Are your ears jaded? Maybe you need new sounds. Try, for example, *The Happy Domra*, a Melodiya/Angel disc featuring Vladimir Yakovlev on the domra with the Osipov Balalaika Orchestra conducted by Viktor Dubrovsky. The domra has three strings, is round-bodied, and sounds a little like a mandolin. (For those interested in more details, it's a descendant of the *gusli*, favored instrument of the *skomorokhi*.) In the educated hands of the soloist it turns some Russian tunes and bizarre arrangements of Paganini, Bizet, and others into a picker's delight. The sound of the domra backed by a forest of balalaikas is something else, and it's very cleanly recorded. If you can hear all the

Continued

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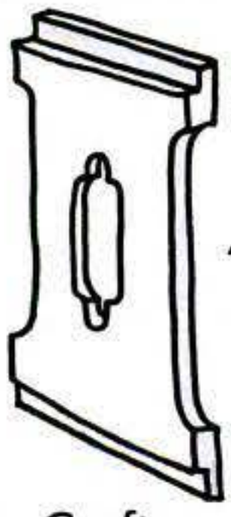
Introducing a drill for the man who does more than just drill holes in wood.

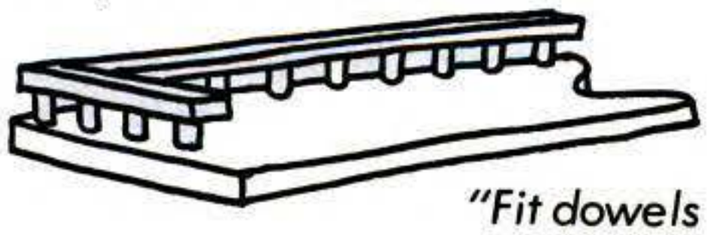
Sears Craftsman Type-1 is a 3/8" heavy-duty drill that can do it all.

1. The Craftsman Type-1 has *ball bearings* built-in at key stress points, it develops a full 1/3 horsepower, and actually puts out more power than other similar drills.



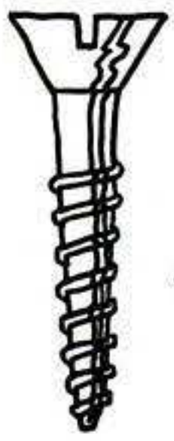
"Cut through an inch of pine in seconds"

2. The Craftsman Type-1 also has the *variable speeds* you need to start and drill a hole exactly where you want it without skipping or skittering around. Whether you're going into wood, steel, concrete, or even ceramic tile.



"Fit dowels with precision"

3. While the variable speeds also help you drive screws, the *reversible* action enables you to take them out, too.



"Drive or draw screws with ease"

4. And, of course, the Craftsman Type-1 is double insulated so it requires no grounding. Its two-prong plug fits any conventional outlet.

Sears Craftsman Type-1 is also unconditionally guaranteed to give complete satisfaction for one year, or return to Sears for a free replacement.

Sears

CRAFTSMAN TYPE I

The drill that's designed for the man who knows what he's doing.

The Craftsman Type-1 Drill, along with the accessories needed to build this desk, are available in Sears, Roebuck and Co. Retail Stores and in the Catalog. Craftsman Type-1 Drill Catalog Number 9 GT 1145.

(Complete plans for building this Captain's Desk are available in the tool department of most Sears stores).

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MODEL	Champion Spark Plug
AMERICAN MOTORS	
(All Models)	
6 Cylinder Engines:	
1971–73 232, 258 cu. in.	N-12Y
1964–70 199, 232 cu. in.	N-14Y
1962–64 196 cu. in. OHV (127-138 h.p.)	H-14Y
1962–65 196 cu. in. OHV (125 h.p.)	H-18Y
1962–65 196 cu. in. "L" Head	H-10
8 Cylinder Engines:	
1966–73 290, 304, 343, 360, 390, 401 cu. in.	N-12Y
1970 390 cu. in. (340 h.p.)	N-10Y
1960–66 287 & 327 cu. in.	H-14Y
BRONCO	
1973 200 cu. in. 6-cylinder	RF-11Y
1972 170 cu. in. 6-cylinder	F-11Y
1973 302 cu. in. V-8	RF-11Y
1972 302 cu. in. V-8	F-11Y
1969–71 302 cu. in. V-8	F-9Y
1966–69 All 6-cylinder Engines	870
1970–71 170 cu. in. 6-cylinder	860
BUICK	
1970–71 250 cu. in. 6-cylinder	RBL-15Y
1972–73 350 cu. in.	RBL-17Y
1971 350 cu. in. V-8	RBL-17Y
1971–73 455 cu. in. V-8	RBL-15Y
1970 455 cu. in. V-8	RBL-11Y
1969 400, 430 cu. in. V-8	RBL-13Y
1967–68 400, 430 cu. in. V-8	BL-13Y
1965–66 400, 401 cu. in. V-8	J-12Y
1969 250 cu. in. 6-cylinder	RN-12Y
1968 250 cu. in. 6-cylinder	N-12Y
1969–70 350 cu. in. V-8	RBL-13Y
1968 350 cu. in. V-8	BL-13Y
1962–67 All V-6 Engines	J-12Y
1965–67 300, 340 cu. in. V-8	J-12Y
1964 300 cu. in. V-8, (½" Reach Alum. Hds.)	L-12Y
1962–66 425 cu. in. V-8	J-10Y
1958–65 401 & 364 cu. in. V-8	J-12Y
* .040" in 1972 & 1973 Models	
CADILLAC	
1969–73	RN-12Y
1968	N-12Y
1957–67	J-12Y
CAPRI	
1972–73 155 cu. in. (2600cc) V-6	XN-9Y
1971–73 122 cu. in. (2000cc)	RF-9Y
1971–72 98 cu. in. (1600cc)	XN-9Y
CHEVROLET	
(CAMARO, CHEVELLE, CHEVY II, MONTE CARLO, NOVA, VEGA)	
4 & 6-Cylinder Engines	
1972–73 140 cu. in. 4-cylinder	RBL-9Y
1970 4-cylinder 153 cu. in.	RN-12Y
1970–73 6-cylinder 230, 250 cu. in.	RBL-15Y
1969 4 & 6-cylinder	RN-12Y
1963–68 4 & 6-cylinder	N-12Y
V-8 Engines	
1971–73 454 cu. in.	RBL-15Y
1971–73 400, 402 cu. in.	RBL-13Y
1971–73 350 cu. in. (4-bbl.)	RBL-13Y
1971–73 350 cu. in. (2-bbl.)	RBL-15Y
1971–73 307 cu. in.	RBL-17Y
1970 400 cu. in. 265 h.p.	RJ-12Y
1970 402 (375 h.p.) & 454 cu. in.	RBL-7Y
1970 402 cu. in. (350 h.p.)	RBL-15Y
1967–68 350 cu. in.	J-12Y
1969–70 350 cu. in.	RJ-12Y
1969–70 307 cu. in.	RJ-12Y
1967–69 302 cu. in.	RJ-10Y
1969 396 (C.I. Hds.) & 427 cu. in.	RN-12Y
Hi-Performance Options	RN-10Y
1969 396 Aluminum Heads	RN-10Y

MODEL	Champion Spark Plug
CHEVROLET—Continued	
1965–68 396 & 427 cu. in.	N-12Y
Hi-Performance Options	N-10Y
1968 307 cu. in.	J-12Y
1955–67 283 & 265 cu. in.	J-12Y
1969 327 cu. in.	RJ-12Y
1962–68 327 cu. in. 250, 275 h.p.	J-12Y
300, 340, 360 h.p. Hi-Perf. Options	J-7
Competition	UJ-6
1961–65 409 cu. in.	N-5
CHRYSLER	
1972–73 440 cu. in. V-8 (4-bbl. carb.)	J-11Y
1972–73 400 cu. in. V-8 (2-bbl. carb.)	J-13Y
1971–72 360 cu. in. V-8	N-13Y
1966–71 440 cu. in. V-8 350 h.p.	J-13Y
Police & Hi-Perf. Eng. 375 h.p.	J-11Y
1961–64 361 cu. in. V-8	J-14Y
1959–71 383 cu. in. V-8 (2-bbl. carb.)	J-14Y
1966–67 383 cu. in. V-8 (4-bbl. carb.)	J-13Y
Police & Hi-Perf. (4-bbl. carb.)	J-11Y
1968–71 383 cu. in. V-8 (4-bbl. carb.)	J-11Y
1959–65 413 cu. in. V-8:	
Two 4-bbl. carbs. (1963-64)	XJ-11Y
Hi-Perf. 300 Series & Police	J-11Y
Standard Engine	J-14Y
COLT	
(Dodge) 1600cc	N-9Y
COMET	
1972–73 6-cyl. 170, 200, 250 cu. in.	RF-11Y
1971 6-cyl. 170, 200, 250 cu. in.	RF-9Y
1971–73 302 cu. in. V-8	RF-11Y
1971 351 cu. in. V-8	RBL-13Y
1969 250 cu. in. 6-cylinder	860
1969 351 cu. in. V-8	F-9Y
1968–69 302 cu. in. V-8	F-9Y
1967–69 427 cu. in. V-8	F-9Y
1966 390 cu. in. V-8	F-11Y
1967–69 390 cu. in. V-8	F-9Y
1960–65 144 & 170 cu. in. 6-cyl.	870
1964–68 200 cu. in. 6-cyl.	860
1964–67 289 cu. in. V-8, (2 & 4-bbl. carb.)	F-9Y
1963–64 260 cu. in. V-8	F-11Y
CONTINENTAL	
1973 460 cu. in.	RBL-11Y
1971–72 460 cu. in. V-8	RF-11Y
1966–70	F-9Y
1958–65	F-11Y
CORVAIR	
1960–68 All Standard Engines, (95 h.p. and under)	L-15Y
1960–68 All others	L-12Y
1969 All	RL-12Y
CORVETTE	
1971–73 454 cu. in. V-8	RBL-15Y
1970 454 cu. in. (390-460 h.p.)	RBL-7Y
1970–71 454 cu. in. (465 h.p.) (Aluminum Heads)	RN-10Y
1961 283 cu. in. V-8	J-7
1971–73 350 cu. in. V-8 (4-bbl. carb.)	RBL-13Y
1969–70 350 cu. in. V-8:	
295, 300, 350 h.p.	RJ-12Y
370 h.p.	RJ-10Y
All other engines see CHEVROLET	
COUGAR	
1971–73 351 cu. in. V-8	RBL-13Y
1971 429 cu. in. V-8	RBL-9Y
1969–70 351 cu. in. V-8 (18mm)	F-9Y
1970 351 cu. in. 4-bbl. 14mm Hds.	BL-11Y
1970 428 cu. in.	F-9Y
1968–70 302 cu. in. V-8 Std. Eng.	F-9Y
1970 302 cu. in. H.O. 14mm Heads	BL-7Y
1967–68 289, 427 cu. in. V-8	F-9Y

MODEL	Champion Spark Plug
COUGAR—Continued	
1968 390 cu. in. V-8	F-9Y
CRICKET	
(Plymouth) 1500cc (92 cu. in.)	N-7Y
DATSUN	
1973 (1800cc) PL610	N-9Y
1971–73 (1600cc - L16 Eng.): PL510, PL521	N-7Y
1971–73 (1200cc - A12 Eng.) LB110	N-9Y
1970–73 (2393 - L24 Eng.) 240Z	N-9Y
1968–70 (1600cc - L16 Eng.): PL510, PL521	N-7Y*
1967–70 (2000cc - U20 Eng.) SRL311	N-7Y
1966–70 (1600cc - R Eng.): SPL311, RL411	N-7Y
1966–69 (1300cc - J Eng.) PL411	N-9Y
1966–69 (1300 - J Eng.) L520, L521	N-9Y
(1200cc - E1 Eng.) PL410, L320	N-9Y
(1500cc - G Eng.) SPL310	N-7Y
(3956cc - P Eng.) L60, KL60	N-7Y
(3956cc - P Eng.) L60, KL60, (Shielded)	XMN-12
All Early Models - ⅜" Heads	J-11
* For Eng. Serial No. above 018000 only	
DODGE (POLARA, DART, DEMON)	
6-Cylinder Engines 1960–73 (OHV)	N-14Y
1957–59 (L-Head)	XJ-7
V-8 Engines	
1973 340 cu. in.	N-12Y
1972–73 400 cu. in. V-8 (4-bbl. carb.)	J-11Y
(2-bbl. carb.)	J-13Y
1972–73 440 cu. in. V-8	J-11Y
1971–73 318, 360 cu. in.	N-13Y
1968–72 340 cu. in.	N-9Y
1966–71 426 cu. in. (2-4 bbl. carb.)	N-10Y
1966–71 440 cu. in. 350 h.p.	J-13Y
375, 390 h.p.	J-11Y
1963–65 413 cu. in. Standard Eng.	J-14Y
Hi-Performance Eng.	J-11Y
1964–69 273 cu. in. (2-bbl. carb.)	N-14Y
Hi-Performance (4-bbl. carb.)	N-10Y
1967 318 cu. in. ⅜" Reach Heads	J-14Y
¾" Reach Heads	N-14Y
1968–70 318 cu. in.	N-14Y
1960–66 318 & 361 cu. in.	J-14Y
1960–71 383 cu. in. (2-bbl. carb.)	J-14Y
1960–67 383 cu. in. (4-bbl. carb.)	J-13Y
Police Hi-Perf. (4-bbl. carb.)	J-11Y
1968–71 383 cu. in. (4-bbl. carb.)	J-11Y
1963–65 426 cu. in. (Do not use ¾" reach plugs)	J-11Y
FORD	
(LTD, GALAXIE, FAIRLANE, FALCON)	
6-Cylinder Engines	
1972–73 240, 250 cu. in.	RF-11Y
1971 240, 250 cu. in.	RF-9Y
1969–70 250 cu. in.	860
1965–70 240 cu. in.	860
1962–65 170 cu. in.	870
1962–70 200 & 223 cu. in.	860
V-8 Engines	
1973 460 cu. in. Police	RBL-13Y
1972 429 18mm Hds.	RF-14Y
1972–73 429 14mm Hds.	RBL-13Y
1971–73 302, 351 18mm Hds.	RF-11Y
1971 429 18mm Hds.	RF-11Y
1971 390	RF-9Y
1971–73 351 14mm, 400 cu. in.	RBL-13Y
1971 429 14mm Hds.	RBL-9Y
1970 351 cu. in. 2-bbl. 14mm Hds.	BL-13Y
1970 351 cu. in. 4-bbl. 14mm Hds.	BL-11Y
1969–70 351 cu. in. Hds. 18mm	F-9Y

Bet your

Of course, this is just our quickie list.

Our complete, unexpurgated whole-world catalog runs t 56 pages jammed full of spark plugs.

So if you're itching to know the right plug for a Strunk lawn mower, a 365 GTB 4 Ferrari, a '55 Ford, a '37 16-cylinder Cadil lac, or why 22 million people have switched to Champion, sen us a dollar.

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MODEL	Champion Spark Plug
FORD—Continued	
1968-70 302 cu. in. Standard Eng.	F-9Y
1970 302 cu. in. H.O. 14mm Hds.	BL-7Y
1970 429 cu. in. Nascar Street Version	BL-7Y
1959-66 352 & 390 in.	F-11Y
1967-70 390 cu. in.	F-9Y
1963-67 289 cu. in.	F-9Y
1966-70 428, 429 cu. in.	F-9Y
1962-68 406 & 427 cu. in. Hi-Perf.	F-9Y
1958-65 221, 260, 332 cu. in.	F-11Y
1958-62 292 cu. in.	F-14Y
IMPERIAL	
1972-73 440 cu. in.	J-11Y
1970-71 440 cu. in.	RJ-13Y
1966-69 440 cu. in.	J-13Y
1959-65	J-14Y
JEEP (American Motors Corp.)	
1972-73 401 cu. in. V-8	N-12Y
1971-73 304, 360 cu. in. V-8	N-12Y
1971-73 232, 258 cu. in. 6-cylinder	N-12Y
1969-71 350 cu. in. V-8	RBL-13Y
1968 350 cu. in. V-8	BL-13Y
1966-71 V-6 Engine	J-12Y
1965-69 327 cu. in. V-8	H-14Y
1965-70 232 cu. in. 6-cylinder	N-14Y
1963-71 4-cylinder	J-8
1963-66 Tornado Engine	L-12Y
LINCOLN	
1973 460 cu. in.	RBL-11Y
1971-72	RF-11Y
1966-70	F-9Y
1958-65	F-11Y
MERCURY (MONTEGO, CYCLONE Incl.)	
1973 460 cu. in.	RBL-13Y
1973 429 cu. in.	RBL-13Y
1972 460 cu. in. V-8	RF-11Y
1972-73 200, 250 cu. in. 6-cylinder	RF-11Y
1971-73 351 cu. in. 14mm Hds.	RBL-13Y
1972 429 cu. in. 18mm Hds.	RF-14Y
1972 429 cu. in. 14mm Hds.	RBL-11Y
1971 429 cu. in. 18mm Hds.	RF-11Y
1971-73 302, 351 cu. in. 18mm Hds.	RF-11Y
1971-73 400 cu. in. 2-bbl.	RBL-13Y
1971 429 cu. in. 4-bbl.	RBL-9Y
1971 200, 250 cu. in. 6-cylinder	RF-9Y
1964-70 200, 250 cu. in. 6-cylinder	860
1968-70 302 cu in. V-8, Standard Engine	F-9Y
1970 302 cu. in. H.O. 14mm Hds.	BL-7Y
1970 351 cu. in. 2-bbl. 14mm Hds.	BL-13Y
4-bbl. 14mm Hds.	BL-11Y
1969 351 cu. in. 18mm Hds.	F-9Y
1966-67 410 cu. in. V-8	F-9Y
1966-70 428 cu. in. V-8	F-9Y
1961-66 390 cu. in. V-8	F-11Y
1967-70 390 cu. in. V-8	F-9Y
1963-68 406, 427 cu. in. V-8	F-9Y
1969-70 429 cu. in. V-8, Std. Eng.	F-9Y
1970 429 cu. in. Nascar Street Version	BL-7Y
1963-65 6-cylinder	870
MUSTANG—MAVERICK	
1973 200, 250 cu. in.	RF-11Y
1972 All 6-cylinder Engines	RF-11Y
1970 170 cu. in. 6-cylinder	860
1971 All 6-cylinder Engines	RF-9Y
1971-73 302 cu. in. V-8 18mm Hds.	RF-11Y
1971 302 cu. in. V-8 14mm Hds.	RBL-7Y
1971-73 351 cu. in. V-8 14mm Hds.	RBL-13Y
1971 429 cu. in. V-8	RBL-7Y
1970 351 cu. in. 14mm Hds.	BL-13Y
1969-70 250 cu. in. 6-cylinder	860

MODEL	Champion Spark Plug
MUSTANG—MAVERICK—Continued	
1968-70 302, 427, 428 cu. in. V-8	F-9Y
1969-70 302 cu. in. H.O. 14mm Hds.	BL-7Y
1970 429 cu. in. Nascar Street Version	BL-7Y
1967-69 390 cu. in. V-8	F-9Y
1965-70 200 cu. in. 6-cylinder	860
1964 170 cu. in. 6-cylinder	870
1964-68 289 cu. in. V-8	F-9Y
1964-65 260 cu. in. V-8	F-11Y
OLDSMOBILE	
1971-73 350 cu. in. (2-bbl. carb.)	RJ-12Y
1971-73 350 cu. in. V-8 (4-bbl.) M.T.	RJ-12Y
1973 350 cu. in. (4-bbl.) A.T.	RJ-12Y
1971-72 350 cu. in. V-8 (4-bbl.) A.T.	RJ-18Y
1972-73 455 cu. in. V-8 (4-bbl.)	*RJ-18Y
* Hi-Perf. use	RJ-12Y
1973 250 cu. in. 6-cylinder	RBL-15Y
1970-71 250 cu. in. 6-cylinder	RBL-15Y
1969 250 cu. in. 6-cylinder	RN-12Y
1966-68 250 cu. in. 6-cylinder	N-12Y
1964-65 All V-6 Engines	J-12Y
1971 455 cu. in. V-8 (4-bbl. carb.)	RJ-13Y
1971-72 455 cu. in. V-8 (2-bbl. carb.)	RJ-18Y
1970 455 cu. in.	RJ-12Y
1969 455 cu. in. (4-bbl.)	RJ-10Y
1969-71 350 & 400 cu. in. (2-bbl.)	RJ-12Y
1969-70 350 & 400 cu. in. (4-bbl.)	RJ-10Y
1971 350 cu. in. V-8 (4-bbl.)	RJ-18Y
1959-68 330, 350, 371, 394, 400, 425 & 455 cu. in. V-8:	
(4-bbl. carb.)	J-10Y
(2-bbl. carb.)	J-12Y
1961-63 Aluminum V-8:	
F-85 Standard Engine	L-15Y
F-85 Power Option, F-85 Power Option, Cutlass, Jetfire	L-12Y
OMEGA	
6-Cylinder Engines:	
1973 250 cu. in.	RBL-15Y
V-8 Engines:	
1973 350 cu. in. (2 & 4-bbl. carb.)	RJ-12Y
OPEL	
1971-73 1900cc (1.9L)	L-87Y
Thru 1970 1900cc (1.9L)	UL-82Y
1700cc (1.7L)	L-87Y
1500cc (1.5L) ¾" Heads	N-9Y
1000cc (1.0L), 1100cc (1.1L)	L-87Y
PINTO	
1971-73 98 cu. in. (1600cc)	XN-9Y
1971-73 122 cu. in. (2000cc)	RF-9Y
PLYMOUTH—VALIANT	
6-Cylinder Engines 1960-73 (OHV)	N-14Y
V-8 Engines	
1973 340 cu. in.	N-12Y
1972-73 400 cu. in. (2-bbl. carb.)	J-13Y
1972-73 400 cu. in. (4-bbl. carb.)	J-11Y
1972-73 440 cu. in. V-8 (4-bbl. carb.)	J-11Y
1971-73 318, 360 cu. in.	N-13Y
1968-72 340 cu. in.	N-9Y
1965-69 273 cu. in. Std. Engine:	
2-bbl. carb.	N-14Y
Hi-Perf. 4-bbl. carb.	N-10Y
1967 318 cu. in. ⅜" Reach Heads	J-14Y
¾" Reach Heads	N-14Y

MODEL	Champion Spark Plug
PLYMOUTH—VALIANT—Contd.	
1968-70 318 cu. in.	N-14Y
1960-66 318 & 361 cu. in.	J-14Y
1961-71 383 cu. in. (2-bbl. carb.)	J-14Y
1960-67 383 cu. in. (4-bbl. carb.)	J-13Y
Police Hi-Perf. (4-bbl. carb.)	J-11Y
1968-71 383 cu. in. (4-bbl. carb.)	J-11Y
1966-71 440 cu. in. Police & Hi-Perf.	J-11Y
1966-71 440 cu. in. Standard	J-13Y
1966-71 426 cu. in.	N-10Y
1963-65 426 cu. in.	J-11Y
PONTIAC	
(INCL. FIREBIRD, TEMPEST, VENTURA)	
4-Cylinder Engines:	
1962-63 195 cu. in.	J-12Y
6-Cylinder Engines:	
1970-73 250 cu. in.	RBL-15Y
1969 250 cu. in. OHC	RN-12Y
1968 250 cu. in. OHC	N-12Y
1967 230 cu. in. OHC	N-12Y
1966 230 cu. in. OHC	J-10Y
1964-65 215 cu. in.	N-12Y
1962 215 cu. in.	L-12Y
8-Cylinder Engines:	
1972-73 307, 400, 455 cu. in.	RBL-17Y
1972-73 350 cu. in.	RBL-15Y
1971 307 cu. in.	RBL-17Y
1971 350 cu. in.	RJ-18Y
1971 400, 455 cu. in. (4-bbl. carb.)	RJ-12Y
1971 400 cu. in. (2-bbl. carb.)	RJ-12Y
1971 455 cu. in. (2-bbl. carb.)	RJ-18Y
1970 455 cu. in. (2-bbl. carb.)	RJ-12Y
1969-70 350 cu. in.	RJ-12Y
1968 350 cu. in.	J-12Y
1969-70 400 cu. in.	RJ-12Y
1967-68 400 cu. in.	J-12Y
1969 428 cu. in.	RJ-10Y
1967-68 428 cu. in.	J-10Y
1959-67 389 cu. in. (2 & 4-bbl. carb.)	J-12Y
(3 - 2-bbl. carb.)	J-10Y
1963-67 326 cu. in.	J-12Y
THUNDERBIRD	
1973 429, 460 cu. in.	RBL-13Y
1972 400 cu. in. V-8	RBL-13Y
1972 429 cu. in. V-8	RF-14Y
1971 429 cu. in. V-8	RF-11Y
1972 460 cu. in. V-8	RF-11Y
1970 429 cu. in. V-8	RF-9Y
1966-69 428 & 429 cu. in. V-8	F-11Y
1961-66 390 cu. in. V-8	F-11Y
1967-68 390 cu. in. V-8	F-9Y
TOYOTA	
1973 Corona Mk II (4M & 2M)	N-9Y
1972-73 Crown (2563cc - 4M)	N-9Y
1971-73 Corona 2000 (1987cc-18RC)	N-9Y
1971-73 Celica (1987cc-18RC)	N-9Y
1971-73 Corolla, Carina (1600cc - 2T-C)	N-6Y
1971-73 Corolla (1200cc - 3K-C)	N-9Y
1971-73 Hi-Lux Pickup (1987cc - 18RC)	N-9Y
Thru 1970 Corona, Mk II (1858cc - 8RC)	N-6Y
Thru 1970 Hi-Lux Pickup (1858cc - 8RC)	N-9Y
Thru 1970 Crown (2253cc - 2M)	N-9Y
Thru 1970 Corolla, Stout	N-9Y
Landcruiser (F-Eng.) ¾" Heads	N-9Y
Landcruiser (F-Eng.) ⅜" Heads	J-10Y
VOLKSWAGEN	
1973 Model 412	N-7Y
1971-72 Models 411 (1700cc)	N-7Y/N-88
1971-73 1600cc Engines	L-88A
1970 & Earlier (All 1600, 1500, 1300)	L-88A

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Dept. P573, P.O. Box 266, Manhasset, N.Y. 11030

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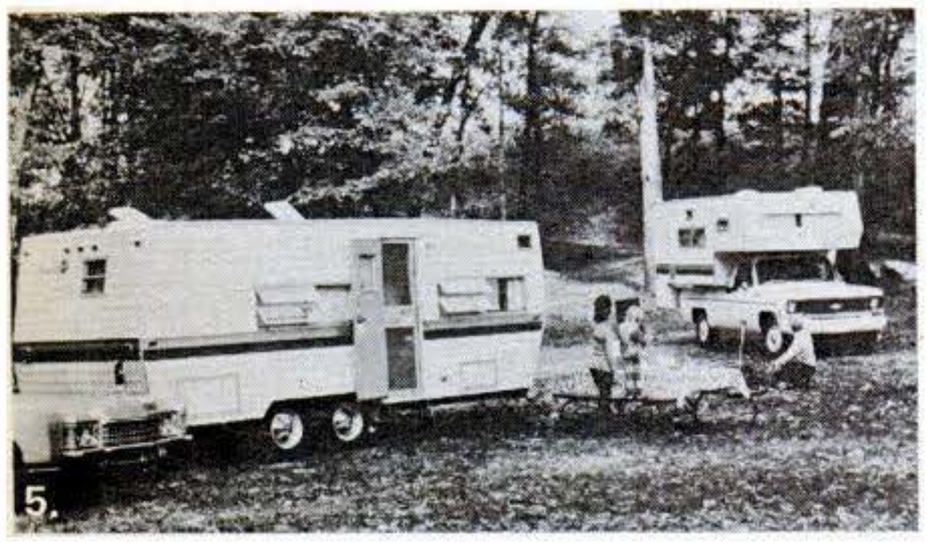
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The New Deal on Wheels

The 1973 Coachmen

Clip & mail to: Coachmen Industries, Inc., P.O. Box 30, Dept. 167, Middlebury, IN 46540
Dear Coachmen,
I'd like more information on the Coachmen "New Deal" in recreational vehicle wheels.
Please send the name of my nearest Coachmen dealer and brochures on:
☐ Royal Coachmen luxury travel trailers (1) ☐ Motor Homes (2) ☐ Deluxe truck campers and travel trailers (3), (4) ☐ Cadet travel trailers and truck campers (5) ☐ QuinStar 5th Wheels (6)
NAME _____
ADDRESS _____
CITY _____ STATE _____ ZIP _____

Look and Listen

[*Continued*]

strands woven by all those flying fingers, your equipment–and your ears–are in good shape.

Next try to distinguish the sounds of 17–repeat 17–different recorders from each other, in a three-disc album from Telefunken called *Frans Bruggen Plays 17 Recorders* (what else?). The music is baroque, the surfaces unbelievably noise-free, and the performance gives a tremendous variety of tone, which the engineering captures flawlessly.

Bruggen, of course, doesn't play his recorders simultaneously. But Paul Horn does play as many as seven flutes at the same time–via recording trickery, on Epic's *Paul Horn Inside II*. The flutes are variously accompanied by the sounds of rain storms, killer whales, and other natural phenomena; the music includes Horn's own compositions (not bad) and some Bach; and the sound is very far-out. Sound-on-sound, multiple tracks, and other special effects make this release interesting.

They also help, but to other ends, an Atlantic disc called *The Divine Miss M*, in which a bombshell named Bette Midler bursts on an unsuspecting public. Can one unknown singer sound just like the Andrews Sisters? You better believe it. Miss Midler sings camp, sings straight, and is great both ways. The sound effects, like her takeoff on Barbra Streisand, are dizzying.

For one of the cleanest, clearest recordings of a small jazz group ever heard, sample London's *Erroll Garner–Gemini*. Playing both piano and harpsichord, Garner is supported by conga drum, percussion, and bass–and not a note of these superb jam sessions is slurred by the sound quality. What Garner can do with "Tea for Two" will leave you gasping. Destined to be a classic.

Franz Liszt, a friend of mine says, is proof of the saying "Empty barrels make the most noise." If your ears require a veritable deluge of sound for refreshment, try London's serving of Liszts's tone poems *The Battle of the Huns*, *Mazeppa*, and *Orpheus*. Some of this stuff is downright awful, but the performance, by Zubin Mehta leading the Los Angeles Symphony Orchestra, is electrifying, and the state-of-the-art sound is spectacular. This is a fine disc to show off your set-up.

For some kind of ultimate aural jolt, you could try Columbia's disc titled *Monster Concert*. Would you believe 10 pianos played simultaneously by 16 pianists? Fomented by Eugene List and an assortment of other light-fingered culprits, the concert presents such items as *The Stars and Stripes Forever*, the *William Tell Overture*, and the *Maple Leaf Rag* in unbridled arrangements. It all sounds incredible. Now, if we had 16 channels . . . PS

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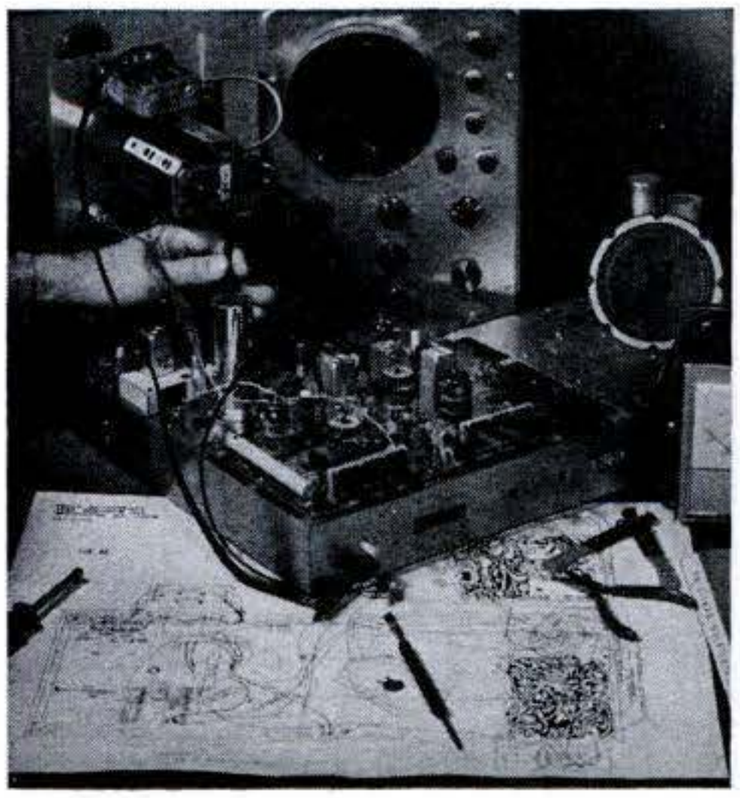
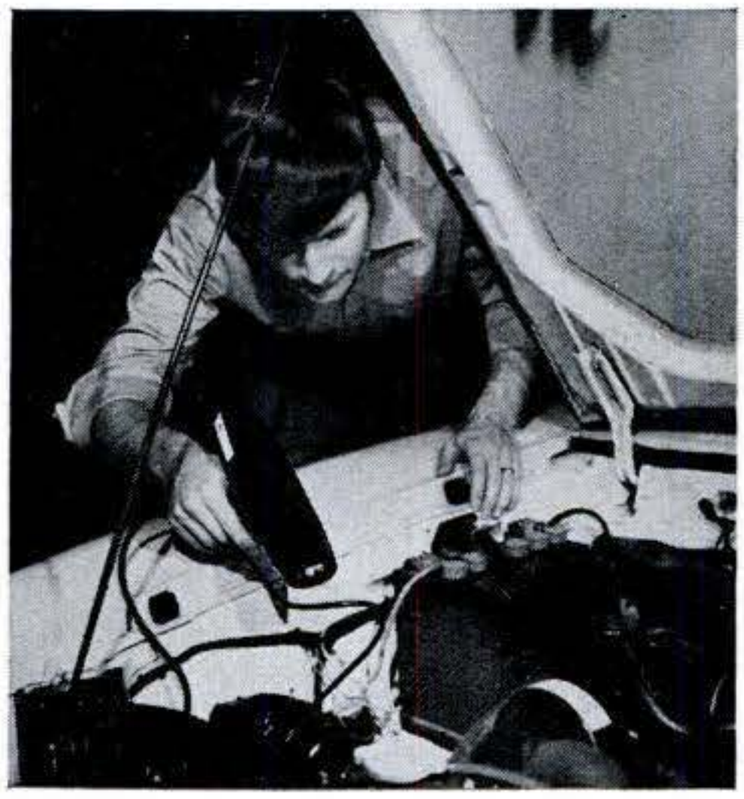
3 needed skills NRI can teach you at home

NRI courses use "bite-size" texts to show you how to service TV-Radios, Repair Cars or Appliances



TV-Radio Servicing

The NRI TV-Radio Servicing course includes your choice of black and white or color TV training equipment. NRI courses cover FCC license preparation, complete communications electronics, aircraft electronics, mobile communications, marine electronics, amateur radio, industrial and business electronics.



Automotive Repair

Take your choice of Master Automotive Technician training or a shorter Automotive Tuneup and Electrical Systems course for the man seeking greater understanding of basic car repair. Both courses include professional equipment so that you get "hands-on" experience and the chance to earn spare-time money making repairs.

Appliance Repair

NRI trains you to fix all kinds of electrical appliances, plus air conditioners, refrigerators, house wiring, electric motors, even small gas engines. An appliance tester is included for fast trouble shooting, so you can begin earning money repairing appliances long before you finish the course.

"Hands-on" training pays off

NRI was the first to supply home study students with custom-designed training kits to give practical hands-on experience as you learn. You get more value from the exclusive Achievement Kit sent the day you enroll, to "bite-size" texts and training equipment. Learning TV-Radio, Automotive Servicing and Appliance Repair at home is easy, exciting, the simplified, dramatized NRI way.

Earn $5 to $7 an hour spare or full time

Tens of thousands of NRI graduates are proof it is practical to train at home in your spare time. Keep your present job while preparing for a better one and earn $5 to $7 an hour extra in your spare time. Fix your own equipment, or earn money making repairs for friends and neighbors. NRI shows you how.

Train with the leader—NRI

The same training innovations which have made NRI the leader in career training at home is now available to you. Let NRI help you step up to better pay, a brighter future. Decide now to move ahead . . . the decision is yours to make. Mail the postage-free card today for a free full-color catalog in the field of your choice. No obligation. No salesman will call.

NRI TRAINING
3939 Wisconsin Avenue
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Introducing the GMC MotorHome. It doesn't ride like a truck. It doesn't look like a box.

1. A NEW ERA IN MOTORHOMES IS BEGINNING.

Before we started building our MotorHome, we studied every other type of motorhome that exists.

We found that the simpler the basic construction, the fewer the problems. So we started with a strong, durable, steel perimeter frame and attached to this a cage of heavy aluminum ribs.

On top of this, we bonded both aluminum and fiberglass panels molded to a smooth finish. It's the same construction people are flying all over the world in.

Except now you'll be driving.

Then we sprayed the interior with a thick, rigid polyurethane foam for thermal insulation and noise suppression. This polyurethane foam has six times the insulation value of fiberglass. Which means the GMC MotorHome has better insulation than most homes. On or off wheels.

2. MORE POWER TO YOU.

To give you the excellent road performance, we installed a 455-cubic-inch V8 engine up front and coupled it to a 3-speed Turbo Hydra-matic transmission. We coupled that to a front wheel drive unit with a 3 to 1 ratio and put it all on top of torsion bar springs and stabilizer bar.

With our low overall body weight, it all means getting up to highway speeds quickly. Excellent traction. Excellent weight distribution.

3. A MOTORHOME IS NO FUN IF IT'S NO FUN TO MOTOR IN.

We took our basic construction and raised it only 15" from the ground. This puts the center of gravity only 37 inches above the ground. For easy handling.

See the rear wheels. We put one behind the other for four reasons: To give you a wider base. More room inside. Greater stability than you'd have with dual wheels. And so we could place a special air spring between the two wheels to pass the bumps from one to the other

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instead of to you!

These air springs are the only ones of their kind on motorhomes.

To keep the weight and balance of the interior within design limits, we fed all the data into a computer. It fed back what we needed to put things where they belong.

4. ABOUT OUR SIX-WHEEL BRAKING SYSTEM.

In addition to power steering, there's a six-wheel braking system with power disc brakes up front and four large finned-drum power brakes in the rear, plus an available leveling device operated from the driver's compartment for parking on uneven ground.

Incidentally, the parking brake grabs all four rear wheels.

5. CHOOSE FROM 15 DIFFERENT FLOOR PLANS. TWO LENGTHS.

The GMC MotorHome is available in 23- and 26-foot lengths. The standard 26' floor plan includes a dinette that converts to a double bed opposite a sofa that turns into double bunks. In the middle, a double sink, 6-cubic-foot refrigerator (it's electric so there's no pilot light that'll blow out), a range and oven with exhaust hood. There's also a bath with all the necessities plus ample cabinet space.

That's one floor plan. There are 14 more available.

6. WE INCLUDED TOP INTERIOR DESIGNERS IN OUR PLANS.

To put the finishing touches on the inside, we had *House and Garden* magazine's interior designers help us.

The driver and passenger seats are high, contoured seats with built-in arm rests. This high-level seating arrangement, combined with the big, wide-angle windshield, offers you panoramic visibility.

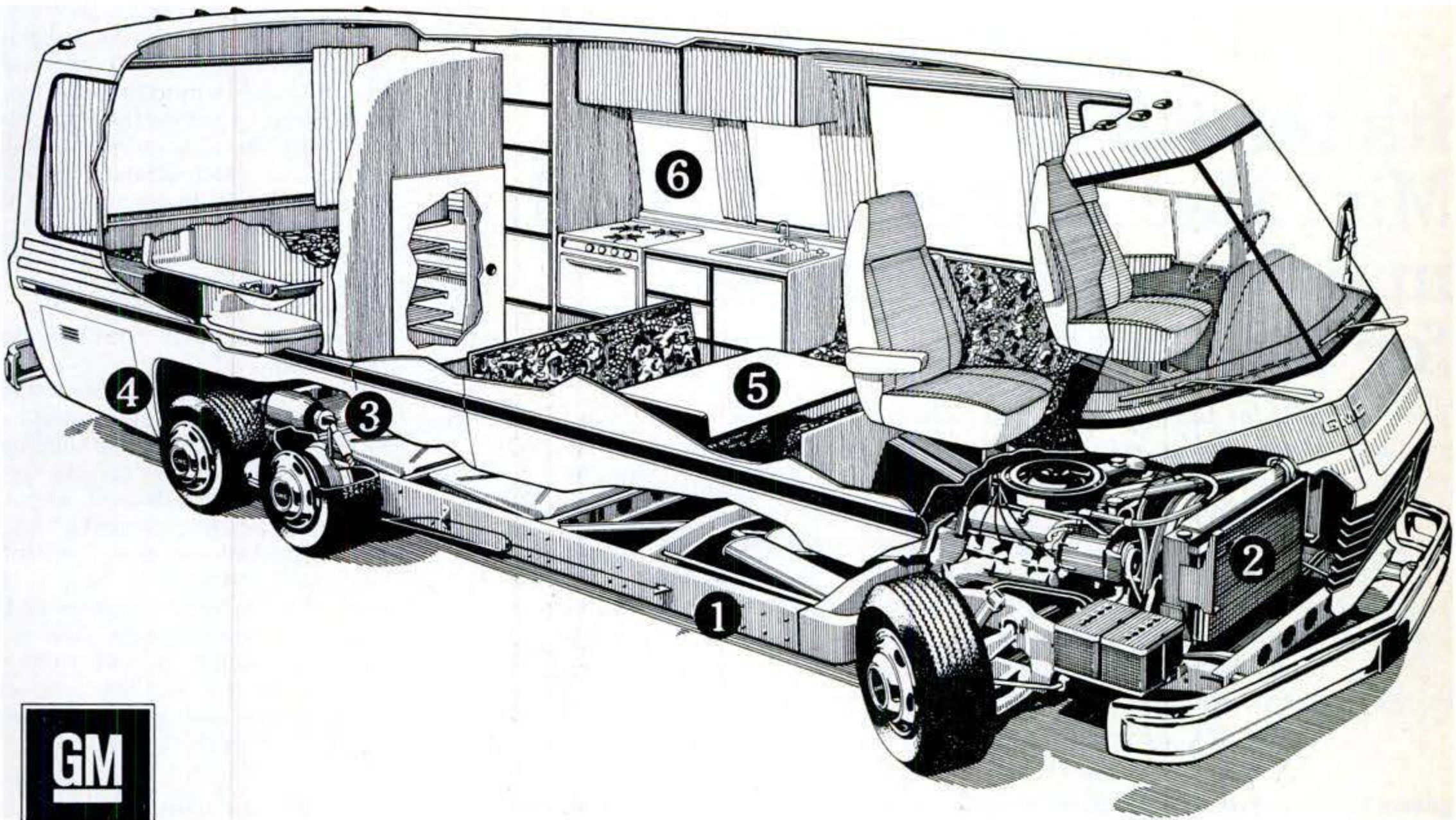
Every counter top has rounded corners. All cabinet knobs are eliminated. Every hinge is concealed.

There are thick, shag or cut pile carpets. And wood-grained vinyl on the walls and cabinets.

You also get a choice of four color-coordinated interior decors.

7. ONE-STOP SERVICE. AFTER-HOUR ASSISTANCE.

Your GMC MotorHome dealer services everything he sells. Inside and out. From the engine to the air conditioner and furnace. And there's a toll-free number you can call and immediately get the number of the nearest MotorHome dealer representative available for after-hour assistance.



GM
MARK OF EXCELLENCE

For our 28-page, four-color catalog, write GMC MotorHome Headquarters, Drawer Y, Dept. 116, Lansing, Mich. 48909.

Better yet, see your GMC MotorHome dealer. He'll be glad to show you around the house. Have a good life.

GMC

The MotorHome from General Motors.

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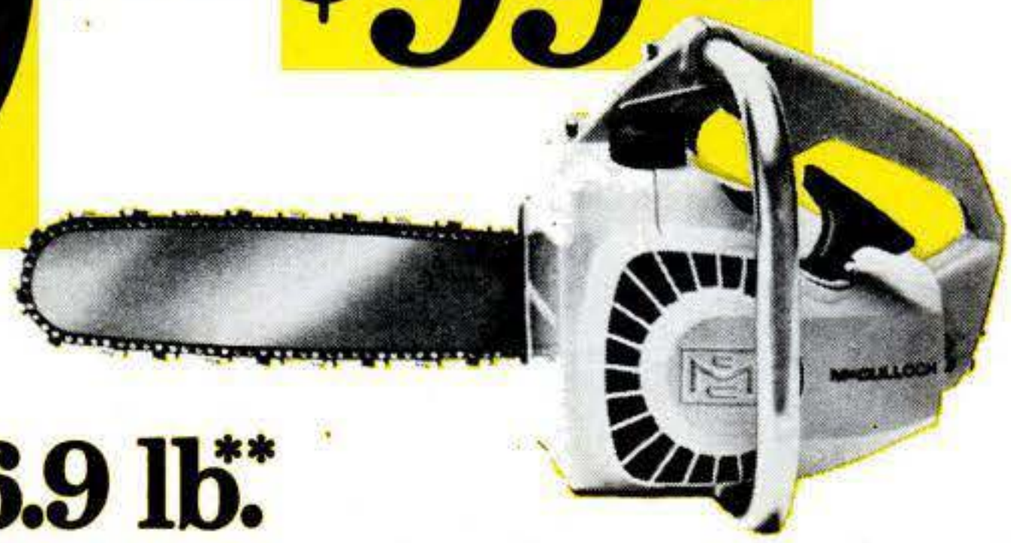
For the man who takes care of his own yard.

All the chain saw you need costs just $99.95*



It's the 6.9 lb.** Mini Mac 1. Only McCulloch makes a saw this light, for this little.

The right tool for the right job—you know that's what counts. So if all you use a chain saw for is limbing, trimming and cutting firewood around your own yard—this is *all* the saw and *all* the power you need! It's lighter than any saw in the world for the price. Its 10" bar will cut a 6" log in just 5 seconds and even zip through 20" logs. And it comes with something you just can't acquire anywhere else—McCulloch's 26 years of professional chain saw engineering know-how. So, now you can get the best saw specially designed for your yard—the Mini Mac 1—for only $99.95.* Why pay more?

20"

If you have bigger jobs, or heavier cutting, check this chart. McCulloch has the right saw for every job.

McCulloch Model	Best For	Weight**	Engine	Bar	Price*
Mini Mac 1	All the saw you need for the average yard.	6.9 lbs.	1.7 cu. in.	10"	$ 99.95
Mini Mac Electric	Can be used outdoors as well as indoors.	7¾ lbs.	110V, 60 cycles, 12 amps, double insulated.	10"	$ 99.95
Mini Mac 1 Automatic	Longer bar for bigger logs, wood and heavier cutting.	7.1 lbs.	1.7 cu. in.	12"	$119.95
Mini Mac 6 Automatic	Deluxe hand grip and longer bar for heavier cutting.	7.1 lbs.	1.7 cu. in.	14"	$129.95
Power Mac 6	More power for orchards, ranches, farm jobs.	6.7 lbs.	2.0 cu. in.	14"	$159.95
Mac 10-10 Automatic	"Sound silencer" for heaviest ranch and farm work.	12.6 lbs.	3.3 cu. in.	16"	$184.95

McCulloch McCulloch Corporation, 6101 West Century Blvd., Los Angeles, Calif. 90045

For best performance, always use McCulloch power-matched chains, bars and sprockets.
**Manufacturer's suggested list price, including bar and chain.*
Prices slightly higher in Canada and Alaska.
***Weight less cutting attachments.*

Recreation

. . . on the go with PS—

U.S. keeps status quo on ORVs

Despite all the ballyhoo last year about straightening out the mess of regulations governing the use of off-road vehicles in federally owned parks, forests, and other areas, little seems to have been accomplished.

The Interior Dept. recently revealed its long-awaited regulations for ORV use on land it administers. The new rules merely reinforce the status quo. Apparently each superintendent running a park, wildlife refuge, or recreational area will have the power to regulate ORV use in his own area.

But the indications are that any areas where ORVs have been permitted will remain open. And prohibited areas will continue to be prohibited.

What's particularly disturbing is that access will be determined by the way local superintendents feel, rather than with reliance on any new research on the ecological impact of ORVs on the environment.

The outlook is that government lands will continue to be a political football between ORV users and ecological pressure groups. And it now looks as though it will take until 1980 before we see the end of the rules tangle and get a real set of regulations on the books.

Camper kit for mini-pickups

This neat camper is designed for sliding into the Japanese mini-pickups that are increasingly popular now. You can build it from plans sold by Glen L Recreational Vehicles, 9152 Rosecrans, Bellflower, Calif. 90706.

The plans, which include full-size patterns and instructions, cost $10. Glen L also sells component kits, appliances, and equipment that will enable you to build a complete camper.

The rig is designed to sleep four

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Roundup

on and off the road

By HERBERT SHULDINER

New Pop-Top puts usable headroom into fifth-wheel trailer bedrooms

There's a lot of room in fifth-wheel trailers—except when you want to stand up to dress or undress in the overhang bedrooms. Now Pop-Top has come to the rescue with a new retractable top specially designed for the duplex bedrooms. The Pop-Top (which is only five inches high when closed) increases 54 inches of headroom to over 80 inches in a 77-by-46-inch area. It's made by Pop-Top, 8903 Mentor Ave., Mentor, Ohio 44060.

persons—two in the cabover double bed, and two in the convertible dinette. The only drawback to this camper that we can see is the 70-inch headroom, which may be okay for people of average height, but will certainly be tough for six-footers.

If your pickup is a larger, domestic breed, PS Plans Div., 355 Lexington Ave., New York, N.Y. 10017, offers plans for a handsome redwood camper designed for the Ranchero, El Camino, or Sprint ($14.95 a set, Plan No. 5508). And in our March issue we offered plans for a telescoping camper to fit most U.S. half-tons (No. 5563, $3.20).

Good news for bicyclists

A big boon for bicycle lovers has just been announced in California. The 444-mile California Aqueduct will soon be converted into one of the world's longest bicycle ways. It will be a protected path for bicyclists, with a network of protective gates that would even keep motorcycles out.

The bikeway now is open for 67 miles from Bethany Reservoir, east of San Francisco, to San Luis Dam, near Los Banos. The extension will take it south of Los Angeles.

A 20-foot-wide service road paralleling the aqueduct was turned into the first stretch. It takes about five hours to cover this 67-mile section, which passes through rugged desert-like country. There are picnic tables every 10 miles, and at the southern end of the completed stretch camping and swimming is allowed.

The expense will be met by dipping into state gasoline tax revenues, as dictated by a bill passed last year in the legislature.

Things to write for

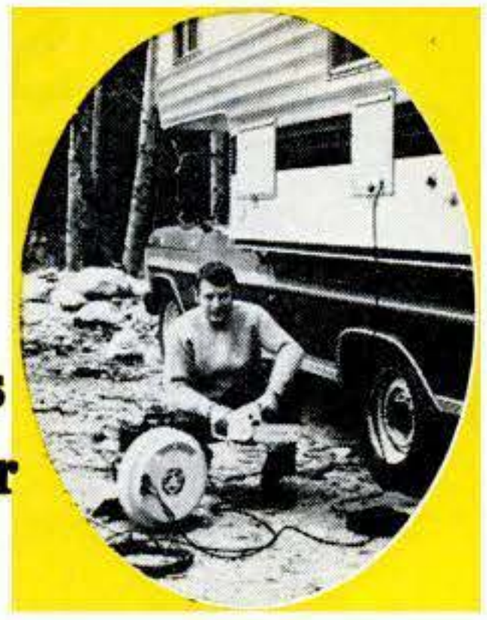
Want to take an adventurous trip? The "Adventure Trip Guide" lists more than 700 outfitters, guides, associations, and services that can help you set one up. The 208-page book is $3.25 from Adventure Guides, Inc., 36 E. 57 St., N.Y. 10022.

A brochure describing 76 trips into the wilderness is available from the Trip Department, Wilderness Society, Western Regional Office, 4260 E. Evans Ave., Denver, Colo. 80222. The trips, which run from four to 12 days, range from the Florida Everglades to the Alaskan tundra. Membership in the society is not necessary.

Johnson Outboards has just announced five new films available for viewing by schools, clubs, and other groups—free. They include "Havasu: The Outboard World Championship," which shows the exciting action of last November's Outboard World Championship.

There's also a 25-minute film called "How's the Water," and three fishing films. Send your request to Solana Studios, 4365 N. 27 St., Milwaukee, Wisc. 53216. PS

For the man who needs power to go



McCulloch Portable Generators

Here's electric power where you need it, when you need it—on camping trips, outdoor building projects, for standby power during storms, blackouts and other power emergencies. McCulloch's super lightweight generators are small enough to fit in the back of your car. And the unique design, with only one moving part, means they're the most reliable you can buy. Three sizes, all with our Double Warranty.

H-1500. 1,500 watt capacity. 68 lbs. 115 volts. 60 cycles. Only **$199.95***

H-2000. 2,000 watt capacity. 83 lbs. 115 volts. 60 cycles. **$289.95***

H-3000. 3,000 watt capacity. 129 lbs. 115 or 230 volts. 60 cycles. **$399.95***

**Manufacturer's suggested list price. Slightly higher in Alaska and Canada.*

McCulloch

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6101 West Century Boulevard
Los Angeles, California 90045

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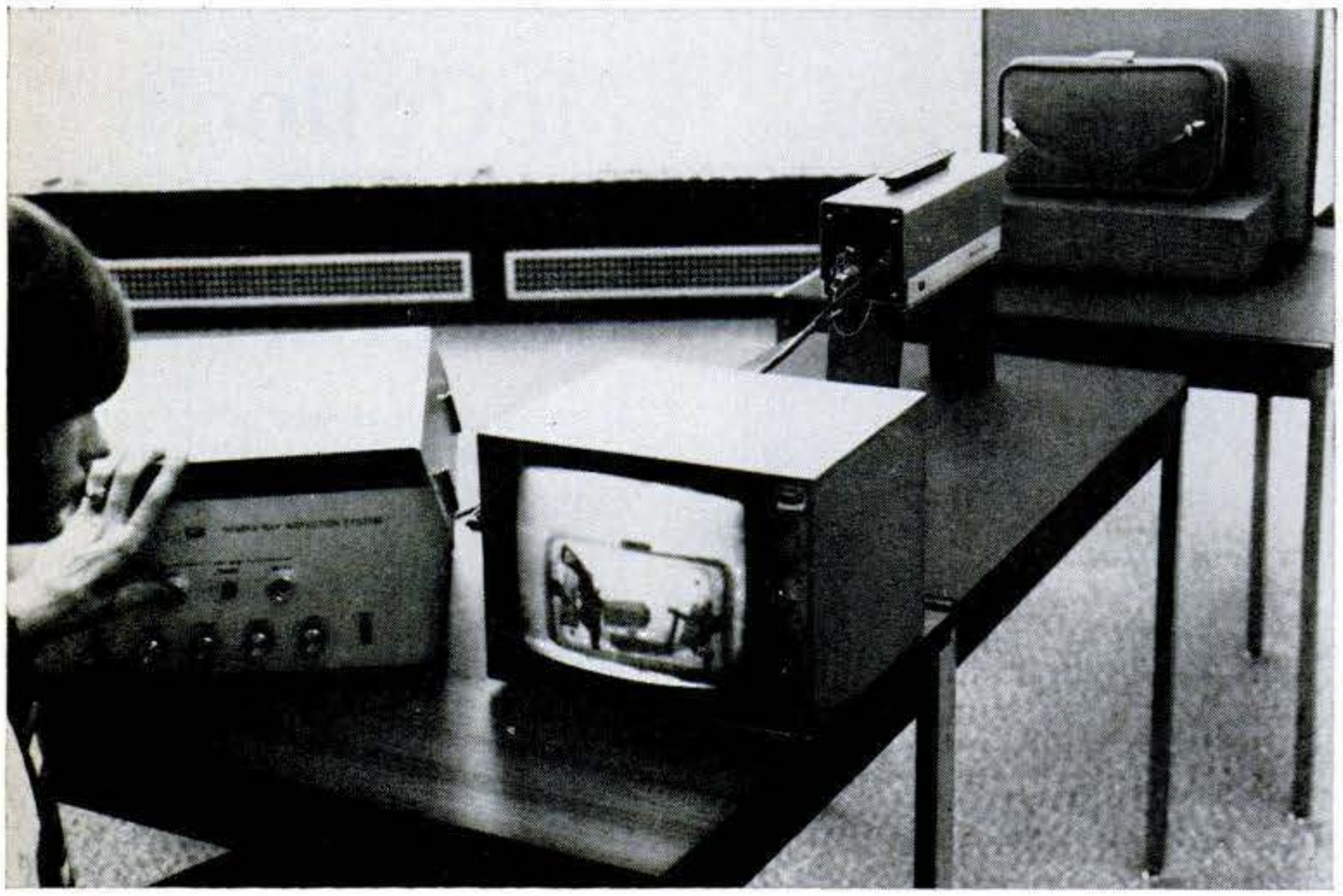
Science Newsfront

Last-minute news and notes to keep you up to date By ARTHUR FISHER

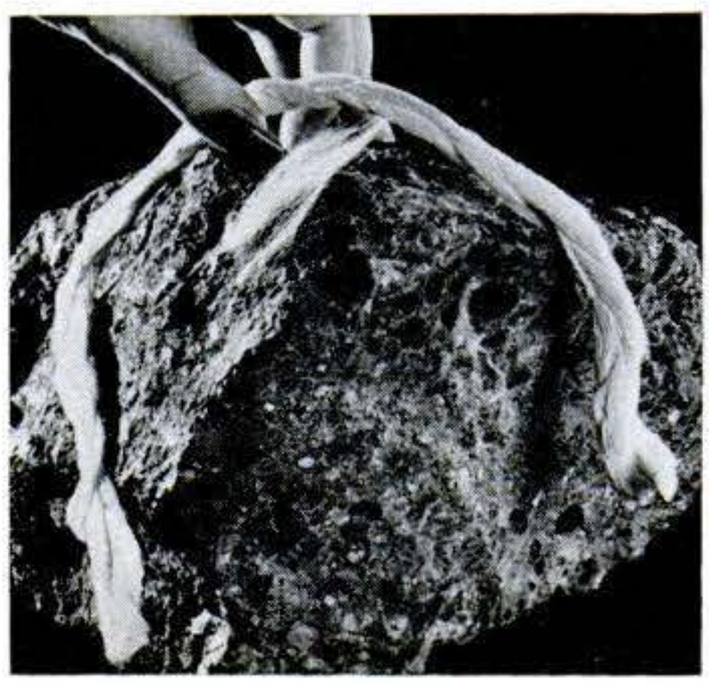


New short-pulse X-ray system speeds airline's baggage check

The stricter government rules on inspection of air travelers' hand baggage, which went into effect at the beginning of the year, have caused some tie-ups, complaints, and not a few embarrassing moments for passengers whose "dirty linen" was exposed to public view. Now Eastern Airlines will begin using a new X-ray screening system, which I saw at Miami Airport, that should speed things up to five seconds per bag and do away with the need to paw through a bag's contents. Developed by Bendix Aerospace Systems Division, the system uses extremely low-dose radiation in pulses lasting only 40 billionths of a second—a combination, Bendix claims, that makes it safe for film, magnetic tapes, and pharmaceuticals. The image, which is intensified and shown on a video screen, can be stored for several minutes.

Heat-resistant fibers

Some materials are perfect for demanding uses except for one thing—they simply cost too much to make. Now Alcoa has found a low-cost way to produce 99 percent pure alumina fibers that may be used as a heat-shield in our space shuttle program because they are so highly refractory (heat resistant). Dubbed Saphibers by Alcoa because of their chemical kinship to the gemstone, the fibers are made from alumina (aluminum oxide) refined from bauxite ore, in a new spinning process. They can be woven into rope, like the sample pictured here with a chunk of bauxite. Saphibers can resist continuous temperatures of more than 3300 degrees F, and they also possess such advantageous properties as the ability to resist attack by a wide variety of corrosive substances and relative inertness in atmospheres that could reduce or oxidize other metals. Thus they will be used both as insulation and for metal reinforcing. The cost reduction that will make this possible: from hundreds of dollars a pound for presently available alumina fibers down to an anticipated five dollars a pound or less.

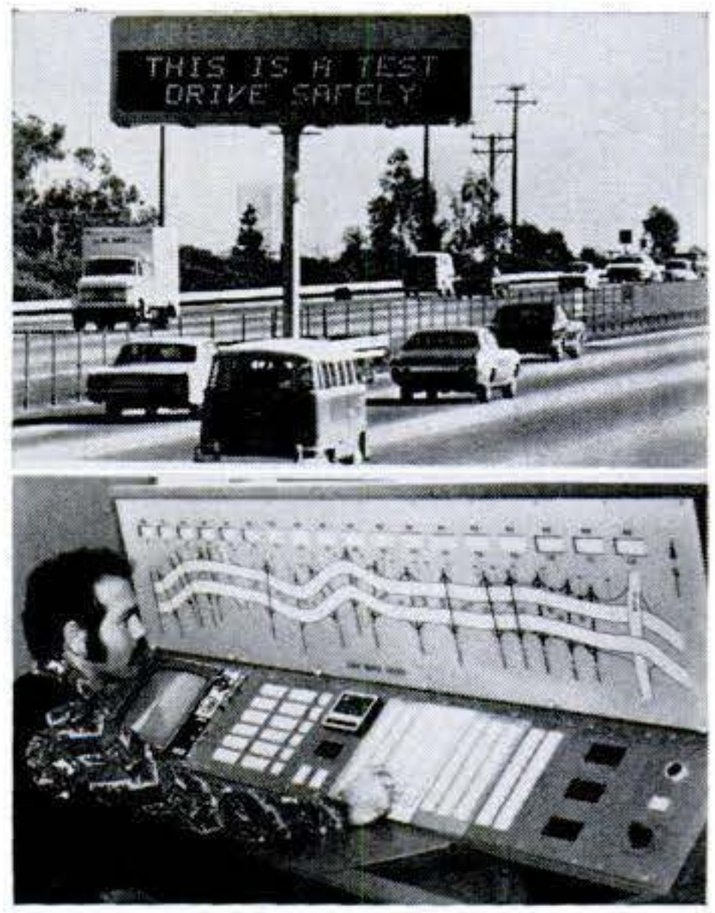


From sea to shrinking sea

Two scientists who have been analyzing the chemical content of ancient oceanic rocks have concluded that the world's oceans may be shrinking. Dr. Clement G. Chase of the University of Minnesota and Dr. Eugene C. Perry, Jr. of Northern Illinois University used the ratio of one isotope of oxygen to another in the rocks as an index to the volume of oceanic water. Their results suggest the seas have been gradually shrinking for three billion years.

Anti-panic for freeways

An experimental traffic-control system that combines a computerized station with road signs for traffic advisory messages has begun operating on one of the world's busiest roads—the Santa Monica Freeway



in Los Angeles. Data from sensors in the roadway and from TV-equipped helicopters is sent to the control station and displayed on its console (bottom). An alert (we hope) operator then selects the most appropriate out of 100 preset advisory messages (such as "accident ahead" or "left-lane blocked ahead") and displays it on the correct signs (top). It was designed by GTE Sylvania.

Metallic hydrogen??

No one has ever seen metallic hydrogen, but astronomers speculate that it must exist inside the giant planets Jupiter and Saturn. Now two professors at Cornell University have a NASA contract to produce the hypothetical stuff here on Earth.

Normally a gas, hydrogen becomes a liquid at about -400 degrees F, and a non-metallic, insulating solid at even lower temperatures. But under enormous pressures, theorists believe it will enter a metallic state where it would be a conductor –or even a superconductor.

Continued

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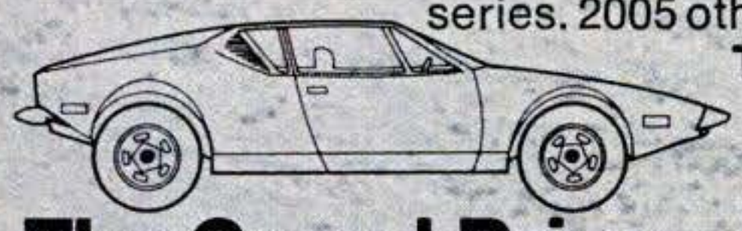
Win this Not-For-Everybody Pantera sports car or $10,000 from Camel Filters!

Who but the "Not-For-Everybody" cigarette would offer a Sweepstakes prize like this Pantera—the official pace car of the Camel GT Challenge road race series. 2005 other great prizes, too!



The Grand Prize is a Pantera or $10,000 cash. This ultra-high-performance sports car is equipped with 351-cubic inch V-8 engine, 4-wheel power disc brakes, 5-speed transmission, magnesium wheels, air conditioning, bucket seats, rack and pinion steering.

The Grand Prize

The 5 First Prizes are Capri 2600 Series sedans—imported for Lincoln-Mercury. The "Sexy European," with air conditioning, bucket seats, power brakes and radio.

5 First Prizes

The 2000 Second Prizes are sporty racing lighters—by Zippo, world's most dependable lighter. With official Camel GT Challenge racing emblem (model 200—brushed chrome).

2000 Second Prizes

OFFICIAL RULES: **1.** On an official entry blank or a 3" by 5" piece of paper, hand print or type your name, address and zip code. **2.** With each entry, send 2 empty CAMEL Filter packages or the words, "CAMEL Filter Cigarettes" printed in block letters on a 3" by 5" piece of paper. Enter as often as you wish, but each entry must be mailed in a separate envelope. Mail to: CAMEL Filter Pantera Sweepstakes, P. O. Box 8254, St. Paul, Minnesota 55182. Entries must be postmarked by Sept. 3, 1973 and received by Sept. 10, 1973. **3.** Winners will be determined in random drawings conducted by Spotts International, an independent judging organization whose decisions are final. **4.** The Grand Prize is a 1973 Pantera, equipped with a 351-cubic inch V-8 engine, 4-wheel power disc brakes, 5-speed transmission, rack and pinion steering, magnesium wheels, and air conditioning (any standard color available in dealer stock), or an alternate prize of $10,000. Five first prizes are 1973 Capri 2600 V-6 sedans imported for Lincoln-Mercury, with V-6 engine, air conditioning, automatic transmission, power brakes, AM push-button radio, bucket seats, and a blue exterior. Two thousand (2,000) second prizes are Zippo lighters (model 200—brushed chrome). **5.** Prizes are non-transferable and non-redeemable for cash. No substitutes for prizes as offered. Only one prize to a family. The odds of winning will be determined by the number of entries received. All 2,006 prizes will be awarded. **6.** Local state and federal taxes, if any, are the responsibility of the winners. **7.** Open to residents of the Continental United States and Hawaii only. Entrants must be 21 years of age or older. Employees and their families of R. J. Reynolds Tobacco Co., its subsidiaries and affiliated companies, its advertising agencies, and Spotts International are not eligible. Void in Idaho, Missouri, Washington, Florida, Georgia, and wherever else prohibited or restricted by law. All federal, state, and local laws and regulations apply. To obtain a list of winners, send a stamped, self-addressed envelope to: CAMEL Filter Winners, P.O. Box 8253, St. Paul, Minnesota 55182. Winners lists will be mailed before November 9, 1973.

Camel Filters. They're not for everybody

(but they could be for you).

©1973 R. J. Reynolds Tobacco Company, Winston-Salem, N. C.

20 mg. "tar," 1.4 mg. nicotine av. per cigarette, FTC Report AUG.'72.

mail to: **Camel Filter Pantera Sweepstakes,** P.O. Box 8254, St. Paul, Minnesota 55182 **CAMEL FILTER Pantera Sweepstakes Entry Blank M**

Please enter me in the Camel Filter Pantera Sweepstakes. Enclosed are two empty Camel Filter packages or the words "CAMEL FILTER CIGARETTES" printed in block letters on a 3" by 5" piece of paper. I certify that I am 21 years of age or older. **No Purchase Required.**

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

mr.
mrs. _____
miss

address _____ phone

city _____ state _____ zip (REQUIRED)

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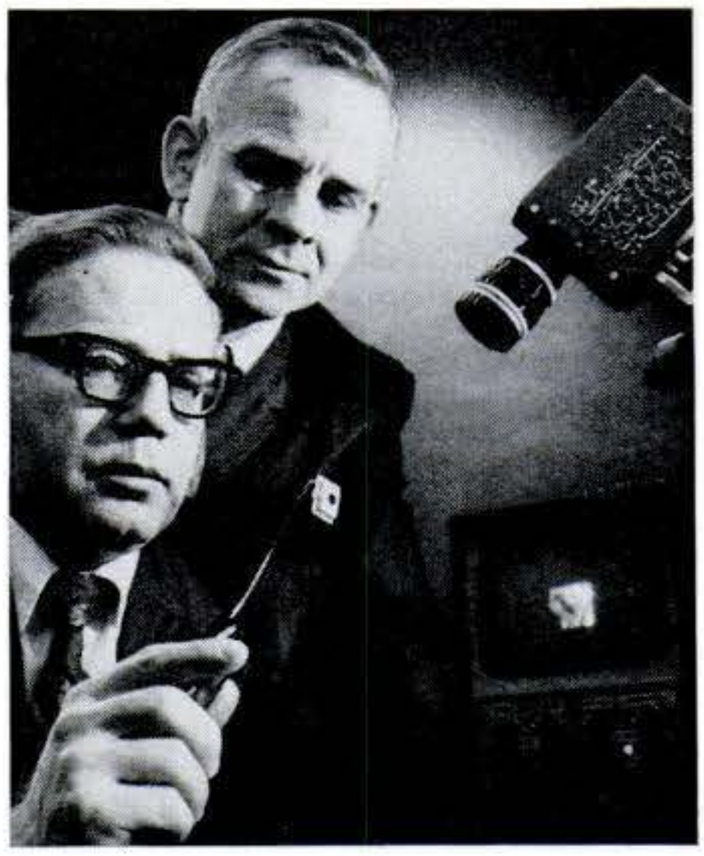
The two scientists, Arthur L. Ruoff and Neill W. Ashcroft, think pressures higher than 15 million pounds per square inch will be necessary—possibly equal to those in the interiors of the massive outer planets. Some Russian scientists claim they may have produced metallic hydrogen via an explosive process, which destroys the resulting product in a flash; the evidence is not convincing.

Tiny TV cameras closer

An inexpensive home TV camera no bigger than a pack of cigarettes? Not yet, but the stamp-sized object you see here may make it possible. The device is a solid-state imager, and it's being held by its developers at the General Electric Research and Development Center, Gerald J. Michon (left) and Hubert K. Burke. An experimental TV camera incorporating their invention is aimed at it—resulting picture can be seen on the TV monitor. The solid-state imager converts an optical image into an electronic video signal, the same job the bulky video vacuum tube performs in current TV cameras.

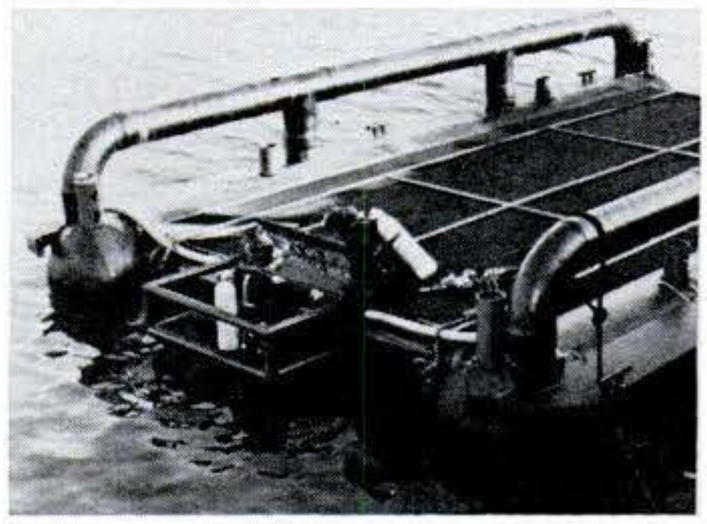
It uses a technique known as "charge injection," in which pairs of capacitors first collect an electrical charge proportionate to the intensity of light falling on them, and then, when they are scanned by integrated circuits built into the imager chip, "inject" the charge into the base of the chip where it can be measured.



The present camera is poor in detail; but a new chip is being built that will have 100 rows of 100 pairs of capacitors and thus improve the resolution nine times over the present 32-by-32 imager.

Undersea catamaran imitates sub

Who needs to simulate the undulating deck of a sub underway? The Navy, in its diver training program.



So the Ocean Sciences Division of the Naval Undersea Center designed SUBTRAP (Submersible Training Platform), a catamaran-like vehicle with steel mesh decking bridging two fiberglass pontoons. Side rails above the pontoons contain buoyancy and ballast tanks. The vehicle is designed to be towed at depths to 100 feet by a surface ship. An operator can make SUBTRAP dive, surface, or hover at depth with controls somewhat resembling those in an aircraft. To maneuver the craft, he selectively floods or blows air into the ballast tanks.

SUBTRAP has other uses, according to its project manager, Ron Seiple: "We could use it to take a class of scuba divers underwater. They could ride the platform down instead of going over the side. There's room for 40 or more." PS

FEATURES ALL FISHING MOTORS SHOULD HAVE. BUT DON'T.

1. "Troll Set" adjustable speed control: Holds the speed you choose—lets you concentrate on steering and fishing. Just set it and forget it.

2. Thunderbolt ignition and Perma-Gap spark plugs: Fire smooth, clean and quiet. All day long. When the sun sets, hit the throttle and go—without a shudder, sputter or cough due to preignition or fouled plugs.

3. One-piece driveshaft and lower unit housing: Fewer nuts and bolts. Fewer joint faces and gaskets. So water stays out, lubricant stays in. Gears and bearings survive the "hard knocks" anglers encounter.

4. Glide-Angle design: Smooth, slanted leading edge of lower unit glides through weeds. Over underwater obstructions. No hang-ups. No tangles.

More Merc fish-getting features: Slick F-N-R gearshift. Shock-absorbing prop hub. Quiet Jet-Prop exhaust. And adjustment free Fixed-Jet carbs. Mercury '73. A lot of things other outboards aren't.

THIS YEAR'S MERCS SET NEXT YEAR'S STANDARDS.

MERCURY OUTBOARDS

Complete range of power: 4, 7.5, 9.8, 20, 40, 50, 65, 85, 115, 150 HP. For nearest Mercury Dealer, see the Yellow Pages under "Outboard Motors." Mercury Marine/Division of Brunswick Corporation, Fond du Lac, Wisconsin/Canada/Australia/Belgium

Let's Go Boating

Share the fun of the great outdoors. Take a friend boating.

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Discover the shortest distance between two points.

The new Harley-Davidson TX-125.

An on-road, off-road, 5-speed, oil injected goodtime machine.

With a look that moves people to envy and delight.

A double downtube frame makes the riding so sweet, that before you know it, you're where you want to be.

Sun-drenched, tingly and feeling like new money.

The Harley-Davidson TX-125.

Restyled. Eager.

The nicest way you'll ever go from one place to another.

AMF Harley-Davidson,
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AMF
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Harley-Davidson TX-125.

The Great American Freedom Machine.

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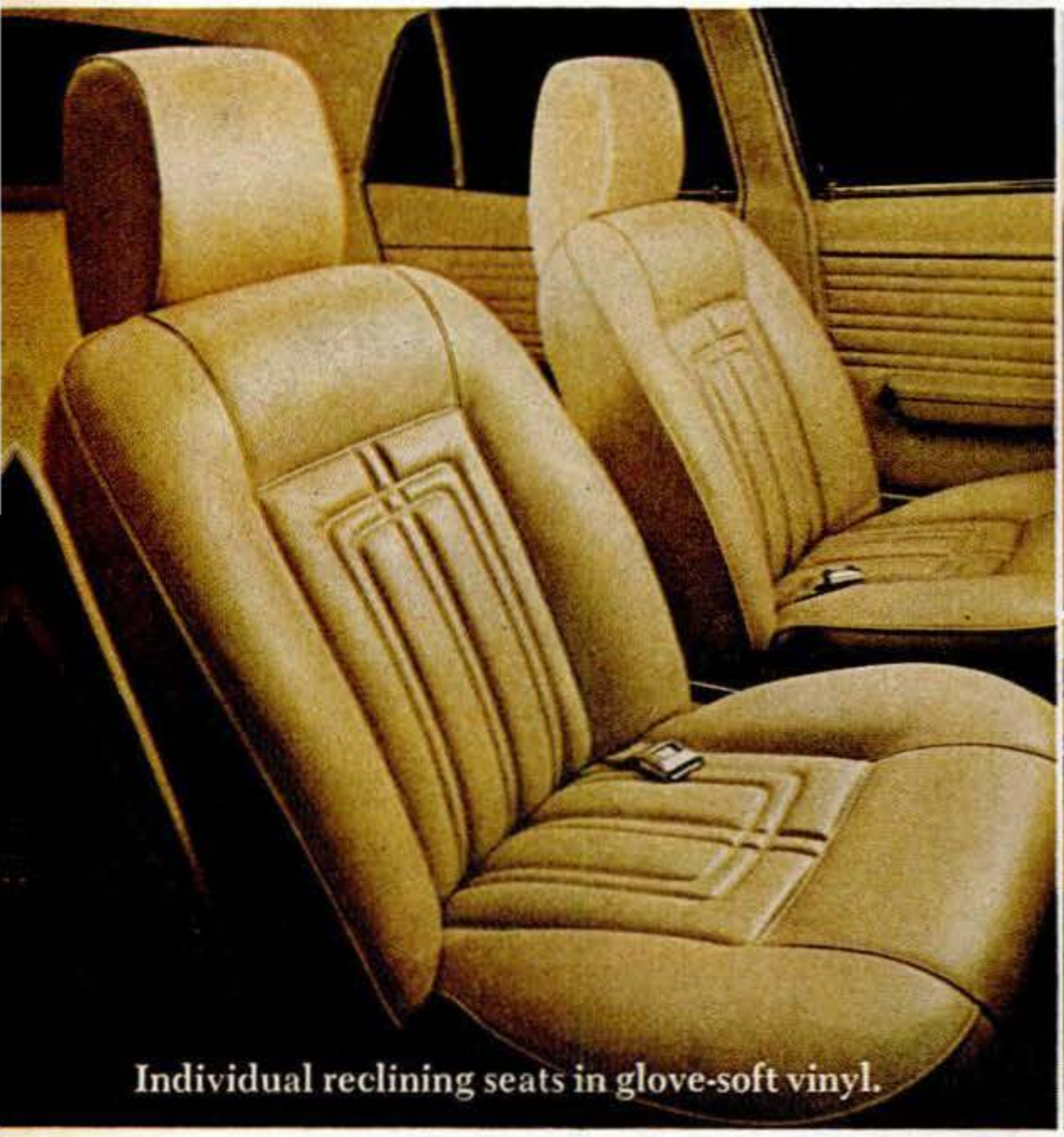
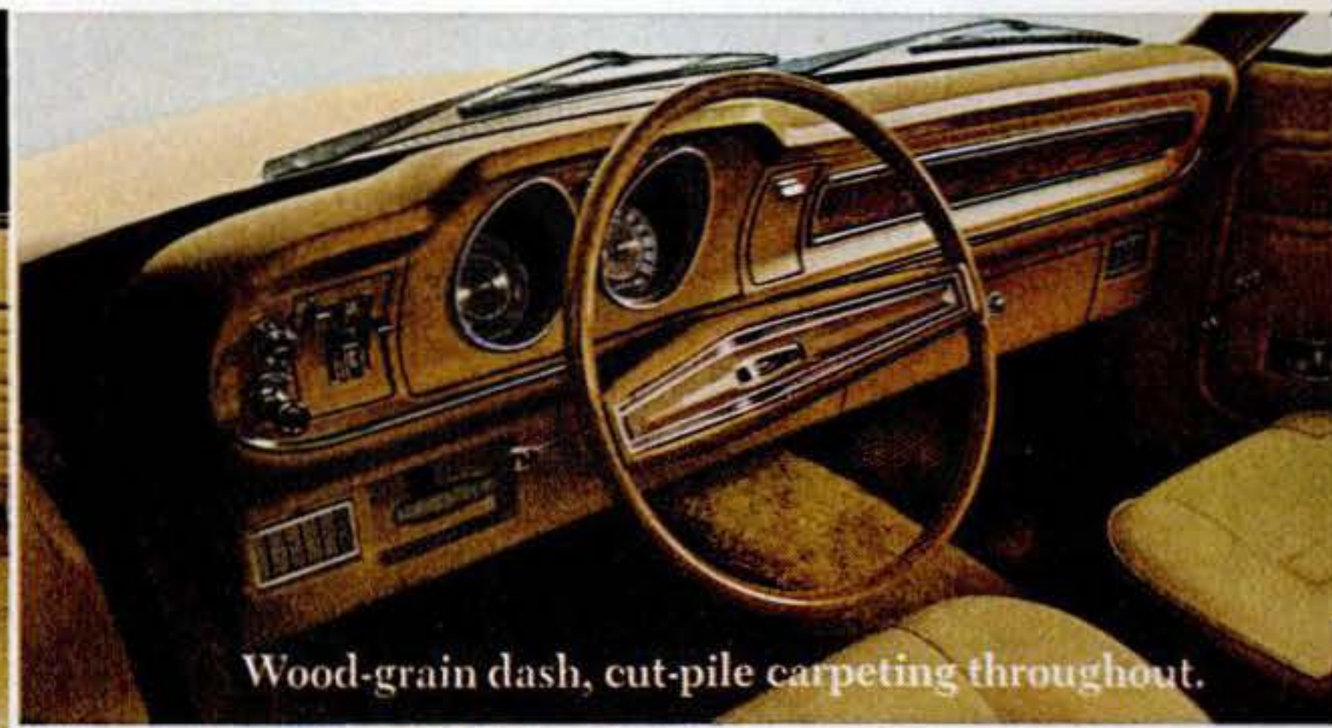
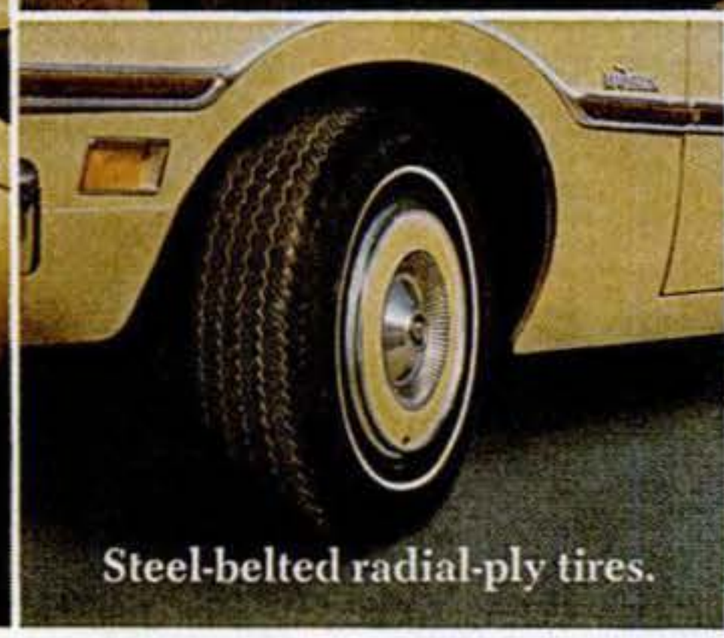
You'd expect this kind of luxury in $6,500 European cars.


Individual reclining seats in glove-soft vinyl.


Wood-grain dash, cut-pile carpeting throughout.


Steel-belted radial-ply tires.

Grained vinyl roof.

PERSONAL-USE REPORT

A Bedroom Clock-Radio That Starts the Coffee in the Kitchen

Besides everything that a good clock-radio should do—like waking me in the morning with the news and weather, and telling me the time, and supplying music (AM or FM) when I'm reading in bed at night, and then turning itself off after a preset interval—this Ward unit has a couple of other tricks:

- It starts the coffee in the kitchen at the same time it wakes me up.
- Or, if I choose, it will start the coffee pot—or any electrical appliance up to 600 watts—any time, when I press a button on its panel.

The secret? A sending unit that transmits a radio signal through my house wiring to remote receiving stations. My coffee pot is plugged into one of these. A lamp in my study is plugged into another; I turn it on from my bedroom by punching the Remote button on the clock-radio. I could also connect an alarm to a station, and set it off from my bed.

The remote-control clock radio sells for $49.88 from Montgomery Ward with one remote-control receiver. Extra receivers are $9.95 each.—*Everett H. Ortner*

Two buttons for remote: Upper remote button "arms" receiving station(s); lower sets auto or manual operation.

Remote receiver turns coffee pot on or off; button can turn off receiver for normal use of pot without reconnecting.

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But not in an American compact at $2,695.*

New comfort and luxury have come to the rugged, reliable Ford Maverick.

Our Luxury Decor Option gets you the luxuries shown at left, plus about 30 others, including steel-belted radial-ply tires. Tests show that the average driver can expect 40,000 miles of tread life under normal driving conditions.

Every 1973 Maverick comes with a refined suspension system, thicker seats, European-type arm rests, carpeting, plush door padding. The ride is quiet.

Test drive a Maverick at your Ford Dealers. And see how luxurious a rugged, reliable compact can be.

FORD MAVERICK

FORD DIVISION

*Car shown: $2,695 sticker price. Dealer preparation, destination charges, title fees and taxes extra.

Better idea for safety . . . buckle up.

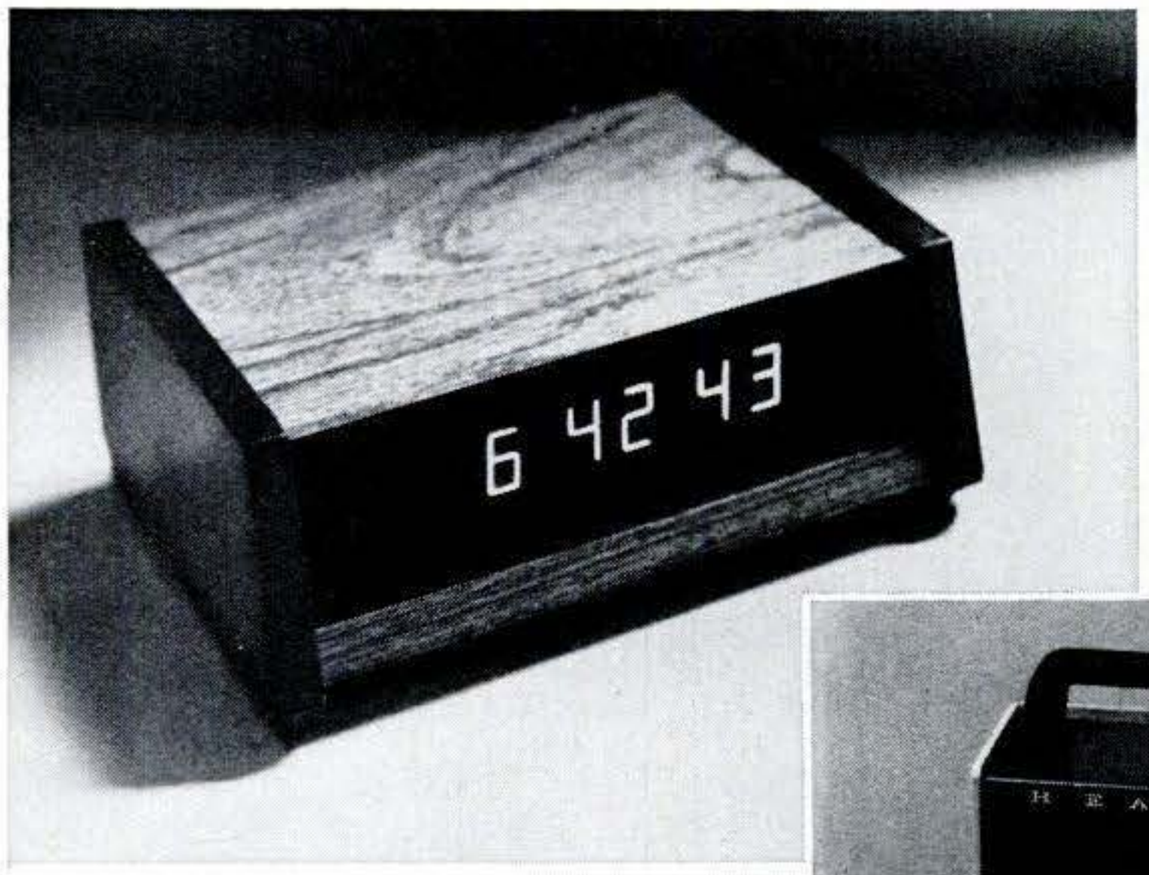
PERSONAL-USE REPORT

Heath Clock and Voltmeter Go Digital

Gears? Hands? Meters? Where are they? Gone. Digital readouts are taking over, and Heath is keeping us up to date with two new kits.

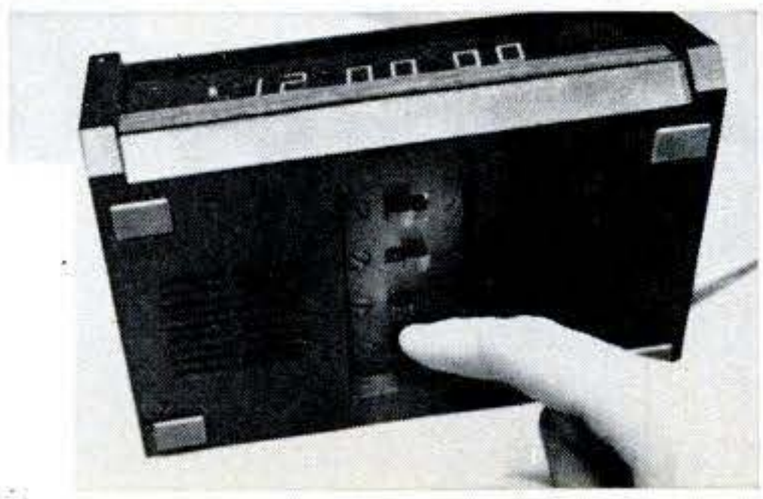
The GC-1005, a 12- or 24-hour digital clock, uses a Mostek MOS/LSI chip for its brain and Sperry seven-segment displays for a sharp, clean readout. A 24-hour electronic "beeper" alarm is built into the package, plus a seven-minute snooze alarm for those who, like me, need an extra jostle. It uses 50- or 60-cycle line frequency as a standard and goes together in just a few hours —for $54.95.

An eight-hour job is the IM-1202, a 2½-digit multimeter. Two tightly packaged PC boards determine 10mV to 1000V DC, up to 700V on AC, 10uA to 2A in current and from one to two megohms of resistance. An excellent buy from Heath, Benton Harbor, Mich. 49022, at $79.95.
—*W. J. Hawkins*



Finished clock, handsome in black plastic with walnut-grain finish. Metal housing of multimeter (below) makes it a rugged piece of workshop gear.

Time-set slide switches—out of way, but handy. Four switches set display, alarm. In rear: alarm arm and snooze.



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PS: What's News...

Keeping You Posted from Behind the Scenes

Take another look at the tire photograph on our cover. At first glance you may have thought it was just a close-up action photo of a car driving through a rain puddle—the photographer was lucky enough to be in the right place at the right time to capture the droplets of spray in midflight. Actually, you're looking at a sophisticated research program in action. Note the nozzle in the lower left of the photo. It's supplying water at a controlled rate—depending on the speed—just ahead of the tire. The wheel is toed in precisely 10 degrees and traveling exactly 55 mph.

If you're knowledgeable about tires, you'll note it's a radial. Elaborate instrumentation was accurately measuring all the forces at work on the tire. Photographer Joe Farkas took the photo on High Speed Ektachrome with a Hasselblad. He was lying prone on a platform attached to the front of the photo car, which maintained a matching speed of 55 mph alongside the test vehicle with a distance of about one foot between the two vehicles. In the story beginning on page 72, you'll find out what they're learning from this research and how it affects your own driving. Incidentally, as we go to press, Ford announced that 75 percent of its '74 models made in the U.S. will come equipped with radial tires. Currently about 28 percent are being delivered with radials.

Welcome aboard, Edwin A. Link

With this issue we are pleased to welcome as our new Consulting Editor, Oceans, a man who is literally a legend in his own time—Edwin A. Link. A barnstorming pilot, a famed inventor (his Link pilot trainer pioneered the simulation techniques that made the Apollo program possible) and explorer, he has been for the last decade a pioneer in undersea research and discovery. His latest invention, the unique, transparent-hulled submersible, *Johnson-Sea-Link* (described in PS September, 1971) is operated by Link's Sea Diver Corp. for the Smithsonian Institution. From his home base, Link Port, located in Fort Pierce, Fla., Link and his associates coordinate all manner of oceanographic research. We'll be reporting on this exciting work in the future.

RCA's "in-line" color TV picture-tube system

Now you can buy a color TV set with the in-line electron guns that you read about in the November 1972 issue of PS. RCA has teamed the new picture tube with their all-solid-state chassis, XL-100, and come out with what they say is the "lowest-priced solid-state color television set in our history." Called the *Projecta,* the new set uses a 15-inch picture tube and is said to sell for about $380. If you read our November article, you will recall that this system uses vertical stripes of phosphors instead of the phosphor dots of conventional color tubes. The big advantage is the elimination of all the color-convergence adjustments needed on sets using the present delta-dot arrangement of color phosphors. Because it is much simpler, there is less to go wrong with the new tube, and the new sets should require less servicing.

Prizewinning PS contributors

Science writer Edward Edelson, who wrote the articles "How Scientists Are Detecting Cancer with Supermagnets," in our March issue, and "Why We're Running Out of Gasoline," in our April issue, is the 1973 winner of the top science-writing prize. Judges for the American Institute of Physics-U.S. Steel Foundation Science Writing Award for Physics and Astronomy picked Edelson's series, "The Mystery of Space," which appeared in the *New York News,* for top nationwide honors.

Both Evan Powell, another contributor, and POPULAR SCIENCE have received an ALMA Award for "communicating effective and accurate appliance information to the consumer." The award is given each year by the Association of Home Appliance Manufacturers. Our entry was "How Ice Makers Work—What to Do If They Don't" and our series on other home-appliance repairs and maintenance.

Shake-up in Santa Ana

After reading on this page in March about predicting earthquakes, reader Ralph Morrow, Jr., who is supervisor of the Marine Electrostatic Gyro unit of Autonetics, sent me a plot of the data from a Biaxial Tiltmeter in the test lab at Autonetics in Santa Ana, Calif., taken before, during, and after the recent Pt. Magu earthquake. The plot shows a slow rise in their lab floor preceding the quake, an increase in rate of rise two days before, a peak during, and an absence of tilt after the earthquake. The Tiltmeter is a two-axis electronic bubble level that can detect fractions of a second of arc of earth tilt. It is produced by the Autonetics Division of Rockwell International. Both California and the U.S. Government have Tiltmeters located along the San Andreas fault feeding data to a computer in Sacramento.

Honda CVCC engine gets a boost

The new Honda engine seems to have won a clear endorsement from the prestigious U.S. National Academy of Sciences (NAS). Facts compiled by NAS's official Committee of Motor Vehicle Emissions (CMVE) rate Honda's CVCC engine as less polluting, more reliable, more efficient, and cheaper than the closest competition. We told you about the engine design and how it works in last month's issue. Members of this blue-ribbon panel of industrial and academic scientists and engineers say Honda engines already have "met the 1975 certification standards and bid fair to meet the 1976 standards" without benefit of expensive, complicated pollution-control equipment.

"In fuel economy, this engine is comparable to a 1972 engine and much superior to a dual-catalyst-equipped 1975 engine," says the committee. "There are no drivability penalties."

Hubert P. Luckett

Editor-in-Chief

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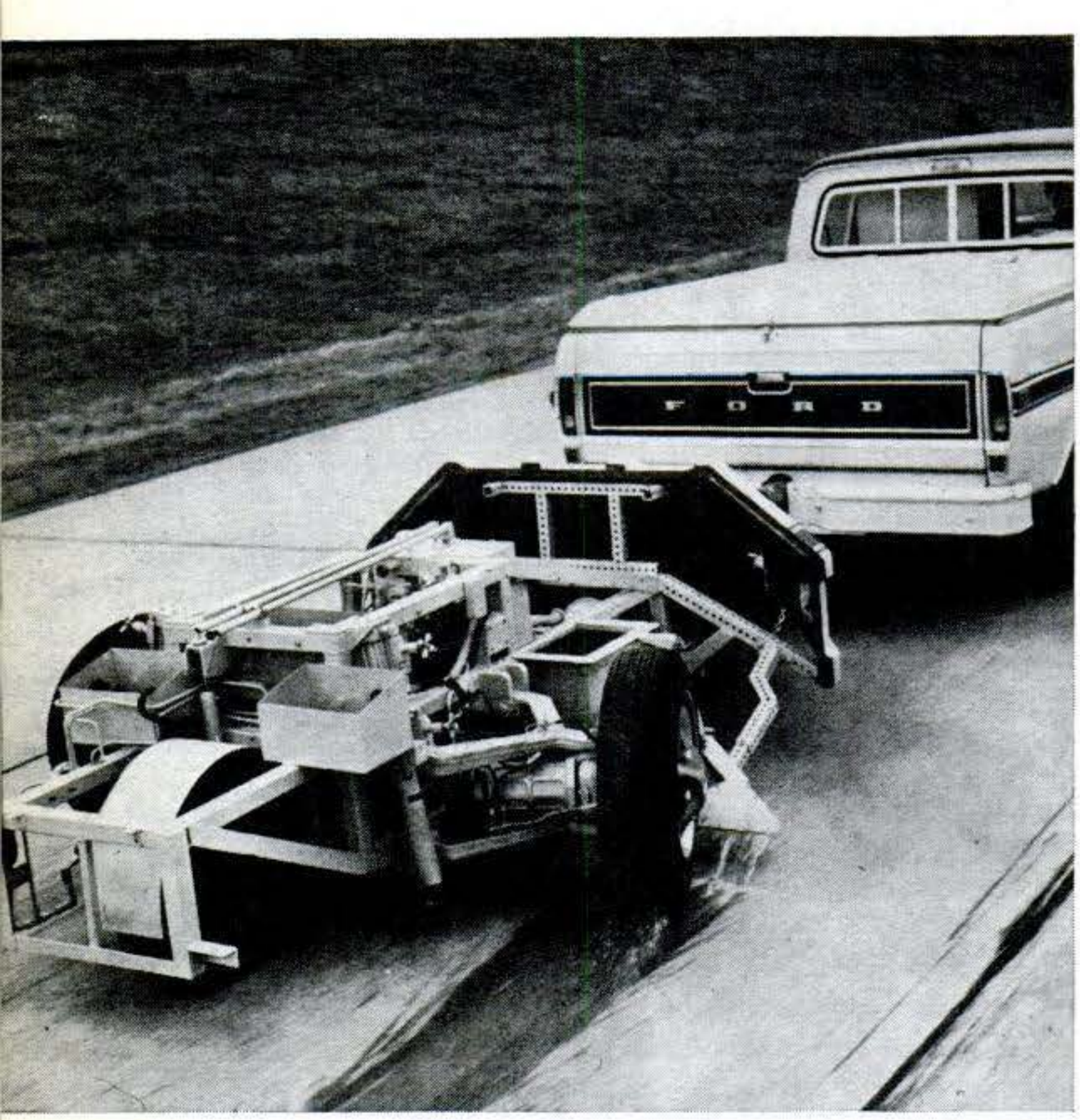
Problems of cornering on wet roads are amply demonstrated by this Chrysler on a flooded jennite-paved skid pad at Michelin's proving grounds at Ladoux in hilly part of central France.

New Research Fights the

By JAN P. NORBYE / *PS Automotive Editor*
and JIM DUNNE / *PS Detroit Editor*

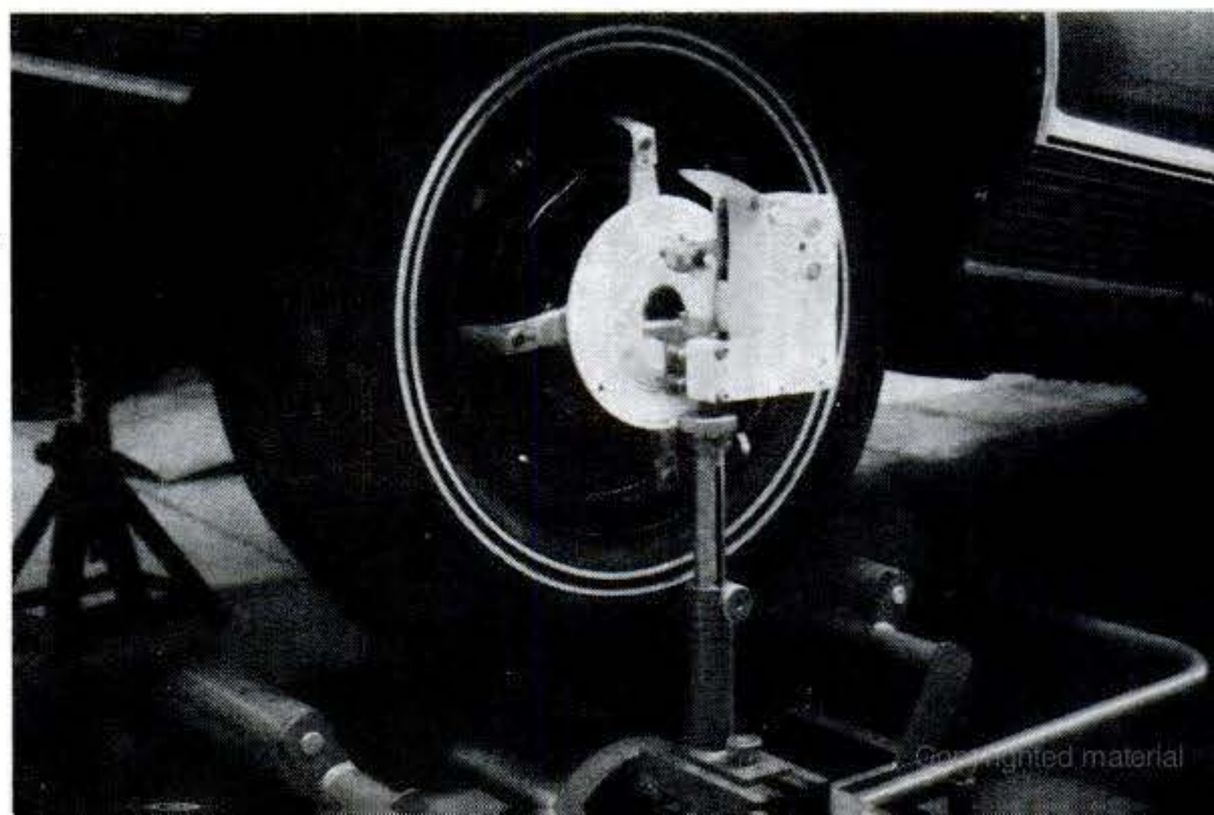
If you drive a car to work, or on your job, you're on the road in all kinds of weather. Chances are you have some experience of skidding, which is the direct cause of many auto accidents. What can be done about it? We're going to tell you:

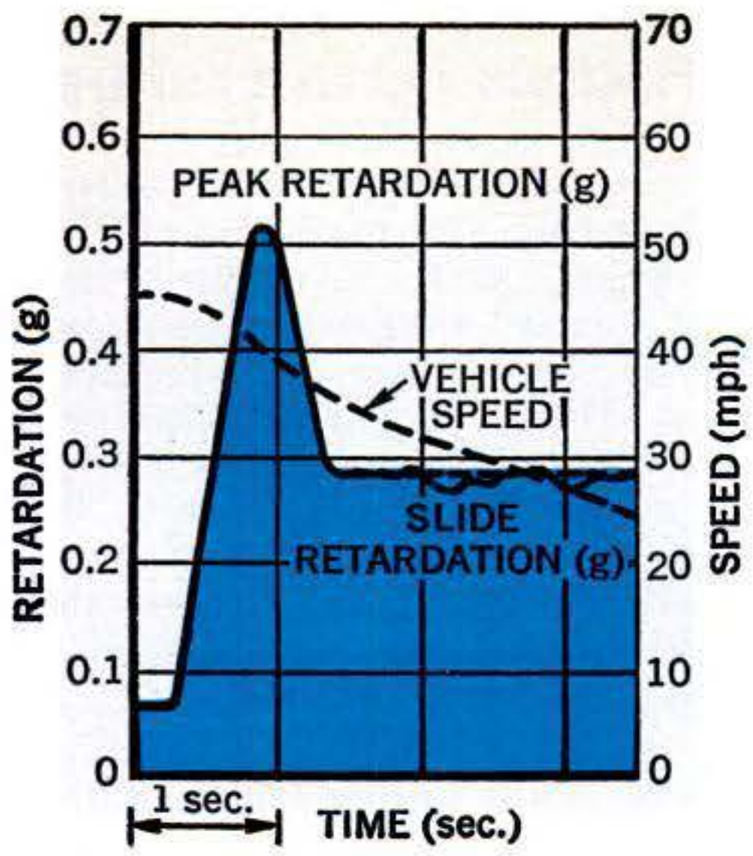
- What the tire industry is doing to improve wet traction.
- What the auto industry is doing to lick the problem.

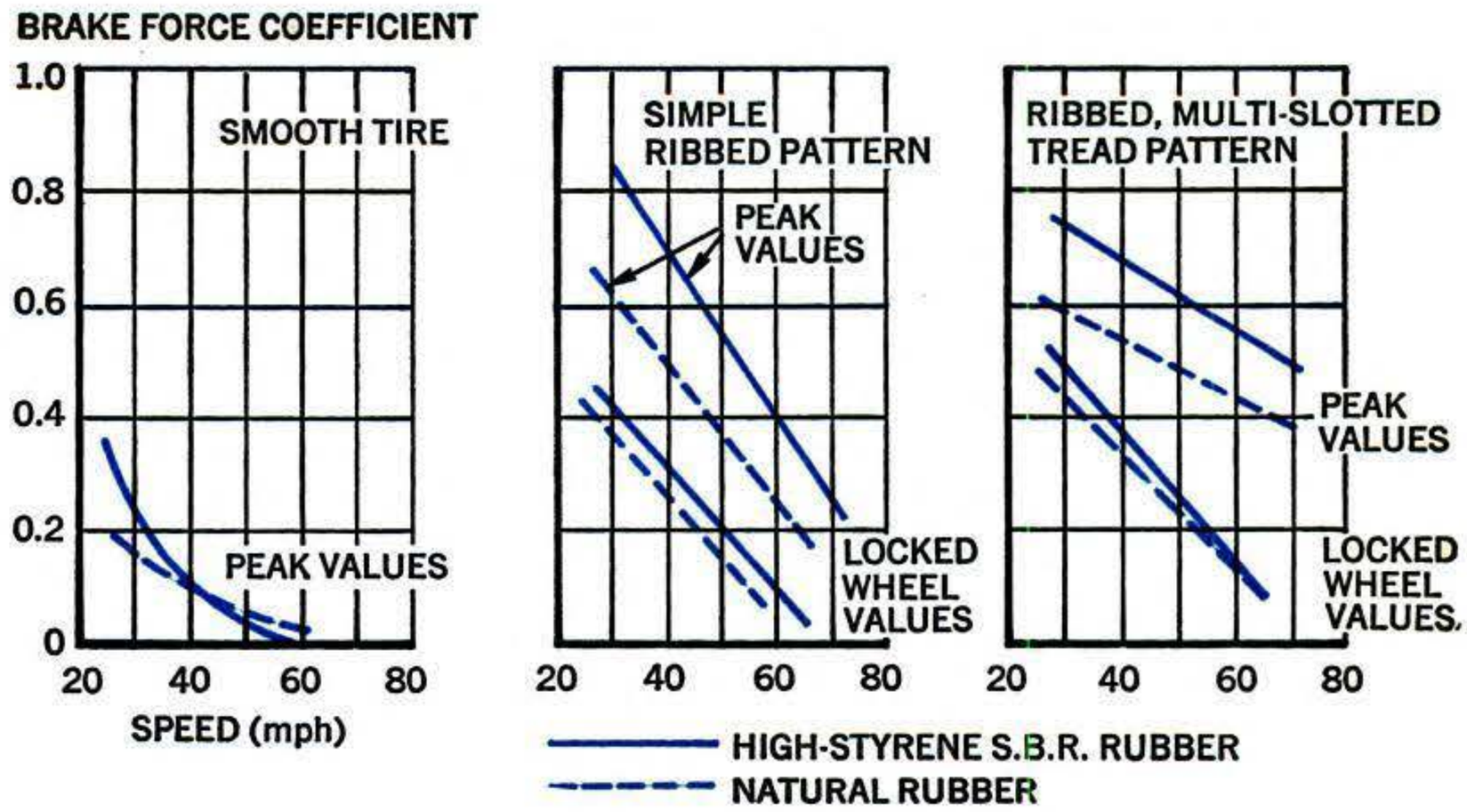


Dynamic-tire-test vehicle developed by Ford supplies reliable data on cornering and braking ability under a variety of conditions. Tow truck has water tank and pump to wet down the roadway immediately in front of the trailer tires. Water flow is proportional to vehicle speed. Wheels can be set for toe-in up to 20 degrees and toe-out up to eight degrees—this photo shows test with 10-degree toe-in, simulating identical but opposite cornering conditions on the two trailer wheels. Thunderbird disk brakes are fitted on both wheels, and are controlled from the truck cab, which is fully instrumented. A 12-channel oscillograph records the steering angle, lateral force, aligning force, tractive force, and speed. From this data, engineers can accurately establish a tire's behavior.

Tire-uniformity indicator checks ride properties of radial tires. Ford and Lincoln-Mercury dealers will be equipped to test and measure flexing forces in tires on the car.







Your worst wet-weather problem: longer stopping distance

Tests have shown that maximum tire-to-roadway friction is developed under partial locking or "creep" when the wheel is turning but the tread is not just rolling on the road—the footprint is also rubbing the surface. Friction falls off when wheel is locked. The first three charts show importance of tread pattern on wet concrete. Solid lines represent a high-styrene SBR compound. Dotted lines are natural rubber. The first chart shows deceleration with a smooth tire, the second chart with a simple ribbed tread pattern, the third chart with a ribbed and multislotted tread. Note that brake efficiency drops as speed rises, regardless of tread pattern and rubber compound. Now you can see how dangerous smooth tires really are.

on Steel-Belted Radial TIRES Hazards of Rain-Slick Roads

• What *you* can do to make your car safer when driving in the wet.

First, let's make it clear that the steel-belted radial tire is not part of the problem–it's part of the solution, in fact.

But the radial tire has by now reached such a high level of perfection that further improvements will be increasingly difficult to get. It has become a matter of prime importance to learn the exact effect on wet traction of small changes in tire design, construction, and materials.

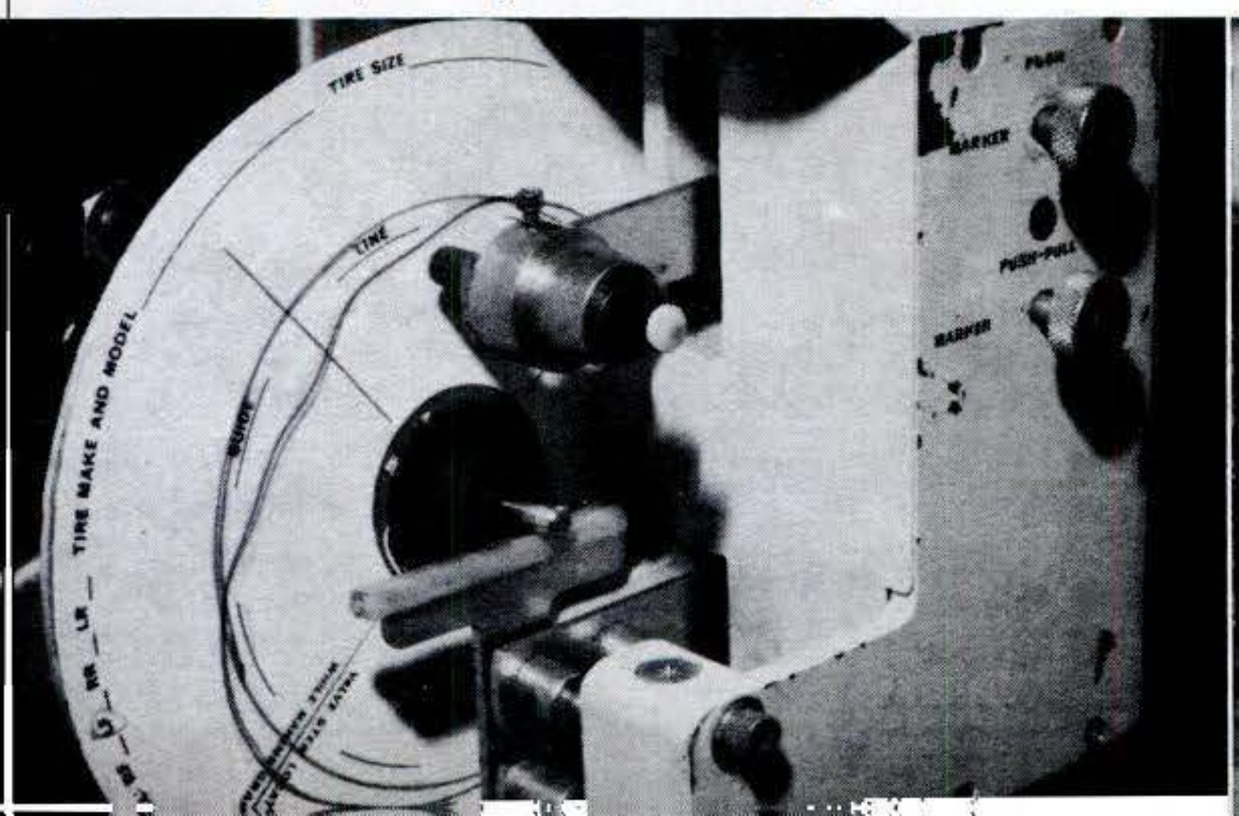
New test equipment has been devised, and new test technology created. The picture on the cover shows a tire running on a wet road with a 10-degree slip angle, mounted on the Ford rig shown at left. All relevant facts are recorded, so that every detail of tire behavior under those conditions is known. Then conditions are changed, one factor at a time. The tire's wet-traction characteristics are mapped. Then the tests are repeated with the next tire. And so on.

That's only one example. The tire companies have their own proving grounds, and can test tire traction on a number of different surfaces. Michelin has five parallel brake lanes, each with a different surface, which give friction coefficients from 0.15 to above 0.5 when wet.

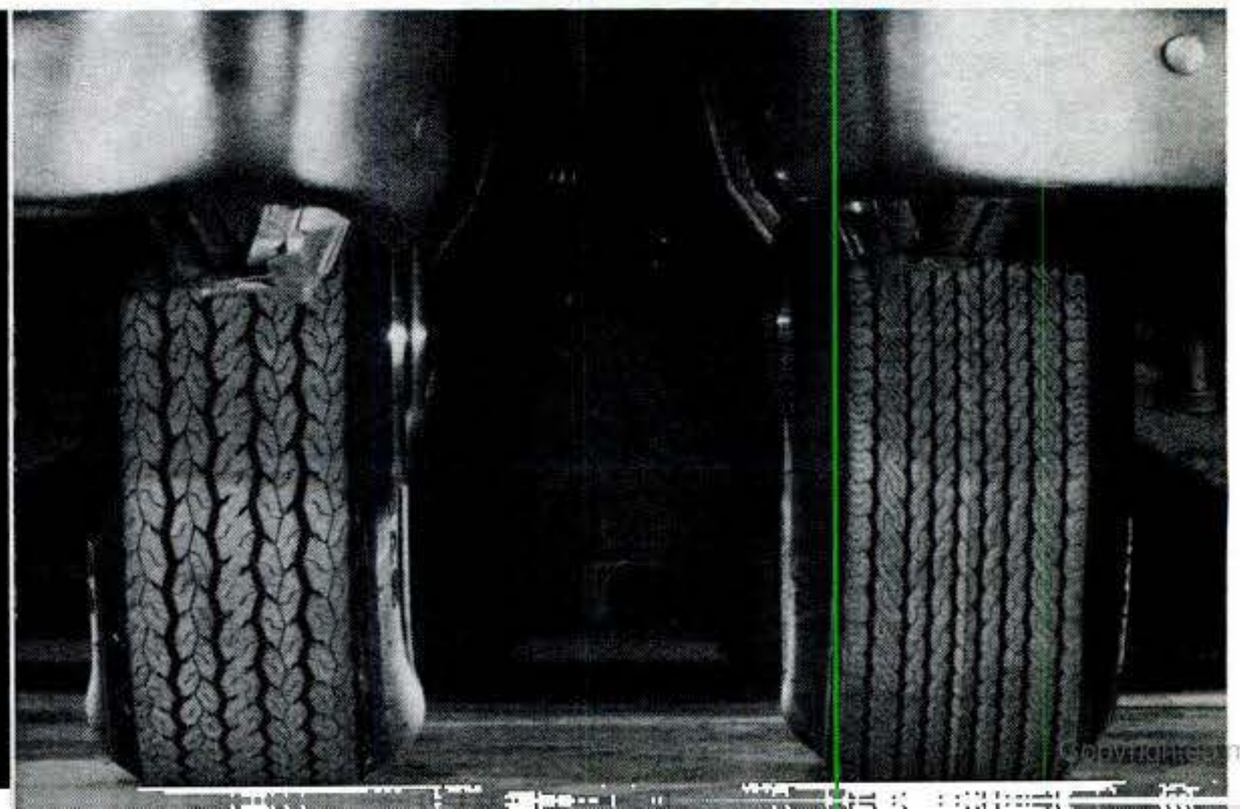
When we talk about skidding, we mean one of two things. The tire may skid because of locking if the brakes are applied too hard for the conditions, or it may skid sideways

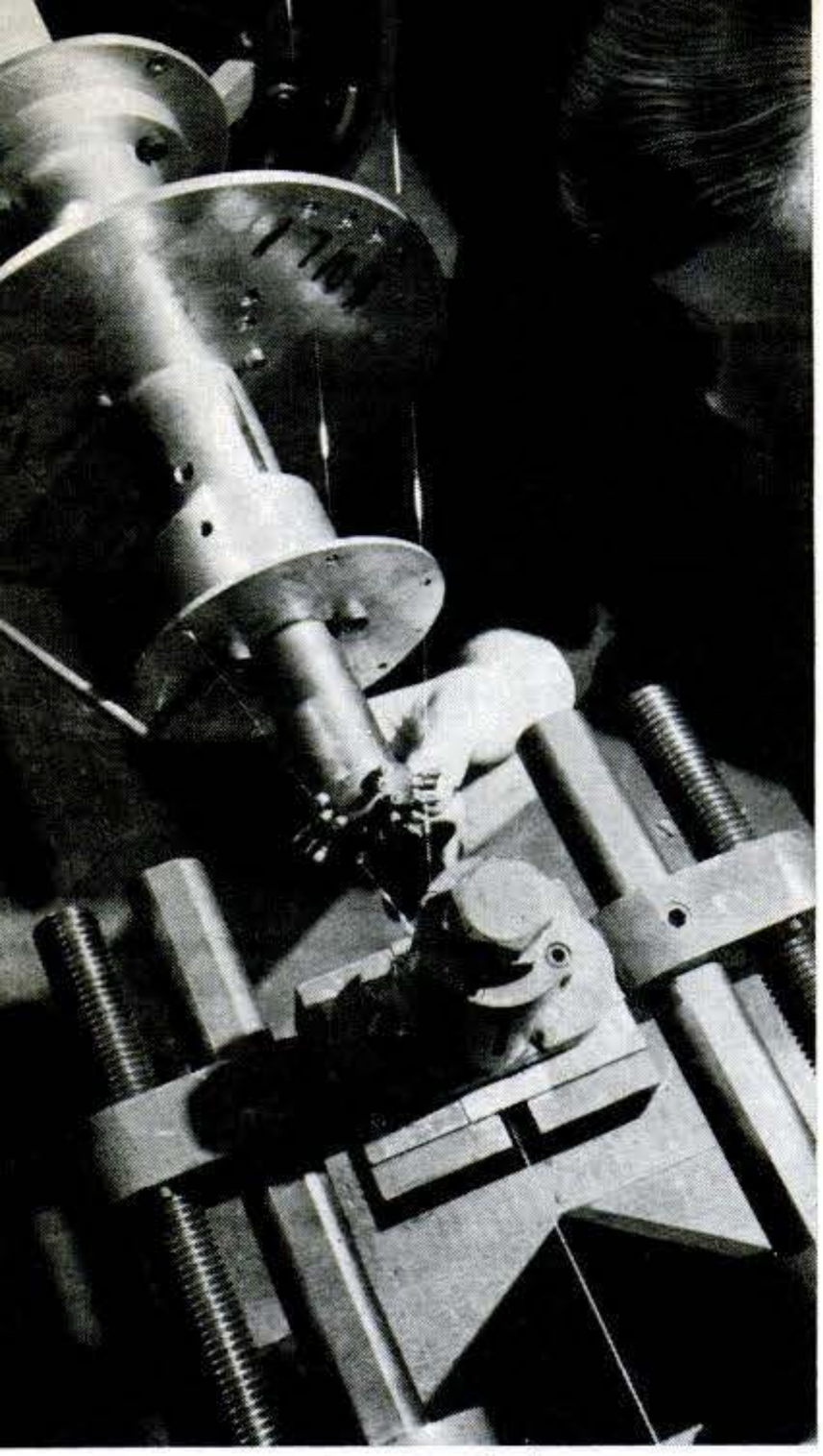
Continued

Reading on tire-uniformity indicator shows high radial force variations, which can set up vibrations in the car's suspension system, usually felt at 65-75 mph.

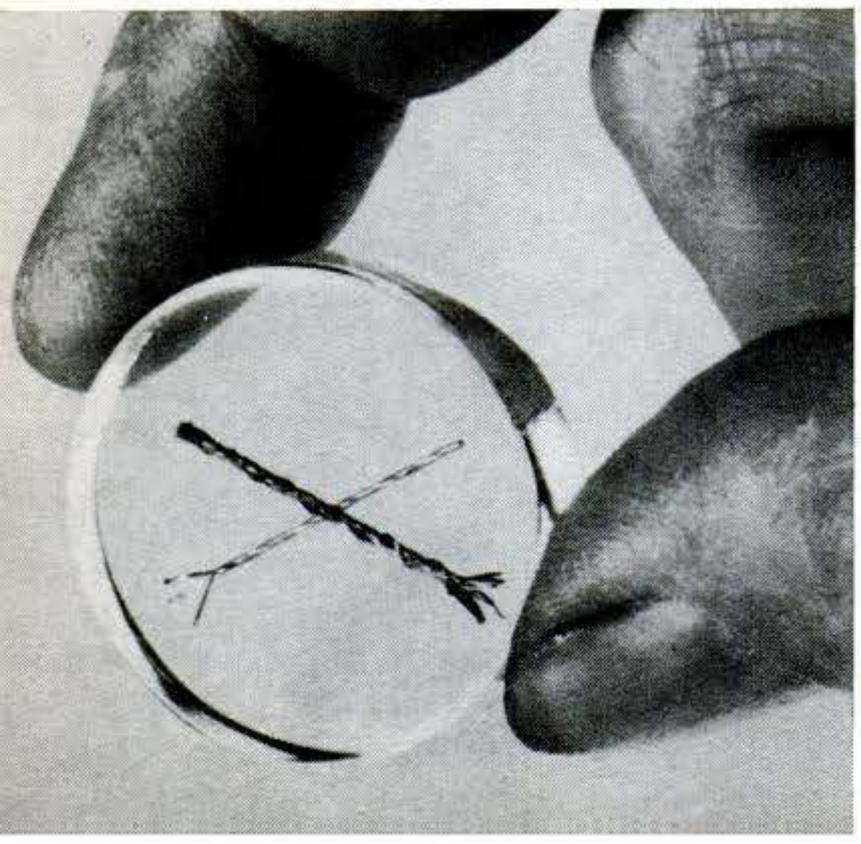


Steel-belted radial (left) shows bulging sidewall compared to conventional tire (right)—normal for radials. Ride height is 1-1½ inches lower (compare bumper height).





Steel wire for tire belts starts out as 6.35mm (¼-inch) rod. After cleaning, rinsing, and lime-coating, it is drawn to 2.0mm and heat-treated. Next step is drawing to 0.8mm, followed by brass-plating (to provide adherence for rubber). Finally, wire is drawn to 0.2mm. Individual wires are stranded, and a number of strands wound to form a wire cord (two types of cord are shown below). The cords are woven into a belt. Belt plies run 18-24 degrees from tire's center line to provide maximum stability. Wires give belt freedom to flex, but keep belt strictly inextensible. Steel wire availability is a bottleneck in radial-tire production. The large steel companies, led by U.S. Steel and Bethlehem, have shown no interest in producing tire wire. All tire companies use imported wire. The only domestic producer of tire wire is National Standard. Belgium's Bekaert, the largest independent tire-wire manufacturer in Europe, is building a plant in the U.S. to supply Akron. Michelin makes its own wire, uses some 200 million pounds of steel a year. Each tire uses about two pounds of wire, depending on size.



George Brush (Firestone): "Radials permit rubber

(while free to roll) under a side force such as cornering.

Can skids be eliminated? Perhaps not, but they can be minimized. Wet traction depends on many variables. First, tire width and footprint length. Tread pattern and tire construction count, too. Car weight and speed are important. Type of road surface and rubber compound are key factors. And finally, water depth. We are going to concentrate on the tire.

Radial footprints. We said steel-belted radials are part of the answer (improved wet traction). Let's explain why:

Radials always keep the footprint on the ground in its full width, whereas a side force lifts part of the tread on bias-ply and bias/belted tires, thus reducing footprint area. Steel belts do a better job in this respect than other belt materials (rayon or fiberglass). Radials also give a longer footprint, as the belt tends to roll like the track of a tank.

The belt also braces the tread. The primary job of the tread pattern is to provide drainage for water. Water must not be allowed to pile up in front of the rolling tire, as it will form a wedge and lift the footprint off the surface (hydroplaning). There must be channels to get the water through the footprint, both backwards and to the sides. Steel-belted radials keep the grooves open—other tires suffer squirm or footprint contraction.

Tire construction and tread pattern determine how much of the footprint will actually be in contact with the road surface. The rest is entirely up to the rubber compound. This is where the tire engineer quits, and the chemists take over.

Rubber compounds. Different rubbers behave in different ways—some are more resilient than others. It becomes a matter of how the rubber reacts to the surface. If you could look at a small part of the footprints of two different compounds, vastly magnified, you would see that one type of rubber conforms more closely to the road surface than the other. For best wet traction, you want a compound with *low resilience.*

Two basic types are used in tread stock: styrene butadiene (SBR) and butadiene (BR). SBR is great for wet traction but wears out fast. BR is hard-wearing but doesn't stick well when wet. The tire chemists' job is to try out different proportions of each, and mix in various additives.

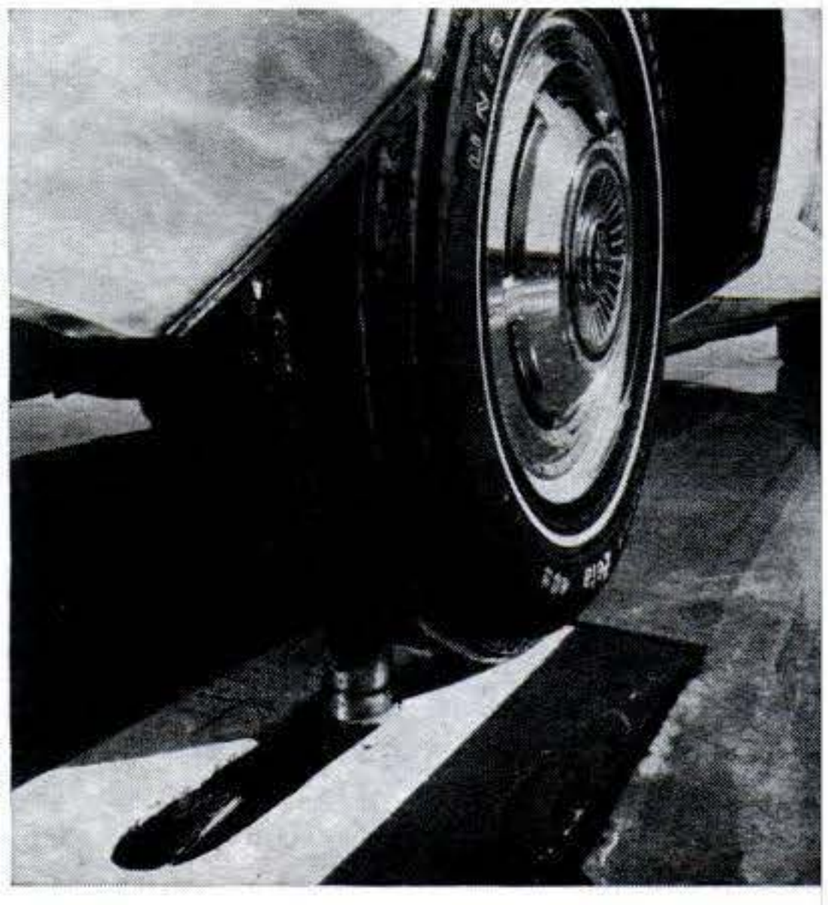
Is there a new magic ingredient on the way? Sorry. Bill Dickerson, engineering vice-president of B. F. Goodrich, says, "We have tested and rejected everything from metal filings to ground walnut hulls." And Dave Shepherd, Goodyear's manager of compounds, told us: "It's just going to be hard, hard work getting traction improvements. We'll get two percent here, three percent here, five percent there."

What about chlorobutyl? Tests by R. C. Keller of Enjay have shown it's a low-resilience additive that's also fair on abrasive resistance. Adding 20 percent chlorobutyl can give 10 percent better wet traction without giving up any tread life.

Special ingredients. Can't the same experiments with new rubber compounds be made with conventional tires? Oh no! That's a key point in the switch to radials. Other tires need special ingredients to guard against tread cracking and cut growth, because of the footprint squirming under the weight of the car. Radials don't squirm. They permit compounds with lower cracking tolerance. Says R. C. Keller: "The advances in compounding are made possible by the switch to radial construction."

You see, the tire chemists can remove ingredients that don't aid wet traction, and replace them with others that do. Steel-belted radials also permit far more aggressive tread patterns without the loss of

Steel belt provides extreme resistance to road hazards. A Uniroyal Zeta 40M rolls across a section of steel pipe, cut on a slant to form an edge as sharp as a hunting knife. Water is added to act as a lubricant, assisting the cutting process. The pipe cuts through the rubber and all plies of ordinary textile tires, but can't penetrate the dual steel belts of this tough tire.



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compounds with lower cracking tolerance"

tread life they would cause in bias-ply tires.

What you can do. To assure wet traction, watch for tread wear, and replace worn tires. As groove depth is reduced, water evacuation capacity falls. Art Neill Jr. of DoT says, "There's far greater difference in stopping distance between new and worn tires of the same type than between new tires of different types." In other words: Even the best radials are less safe *when worn down* than the cheapest *new* tire.

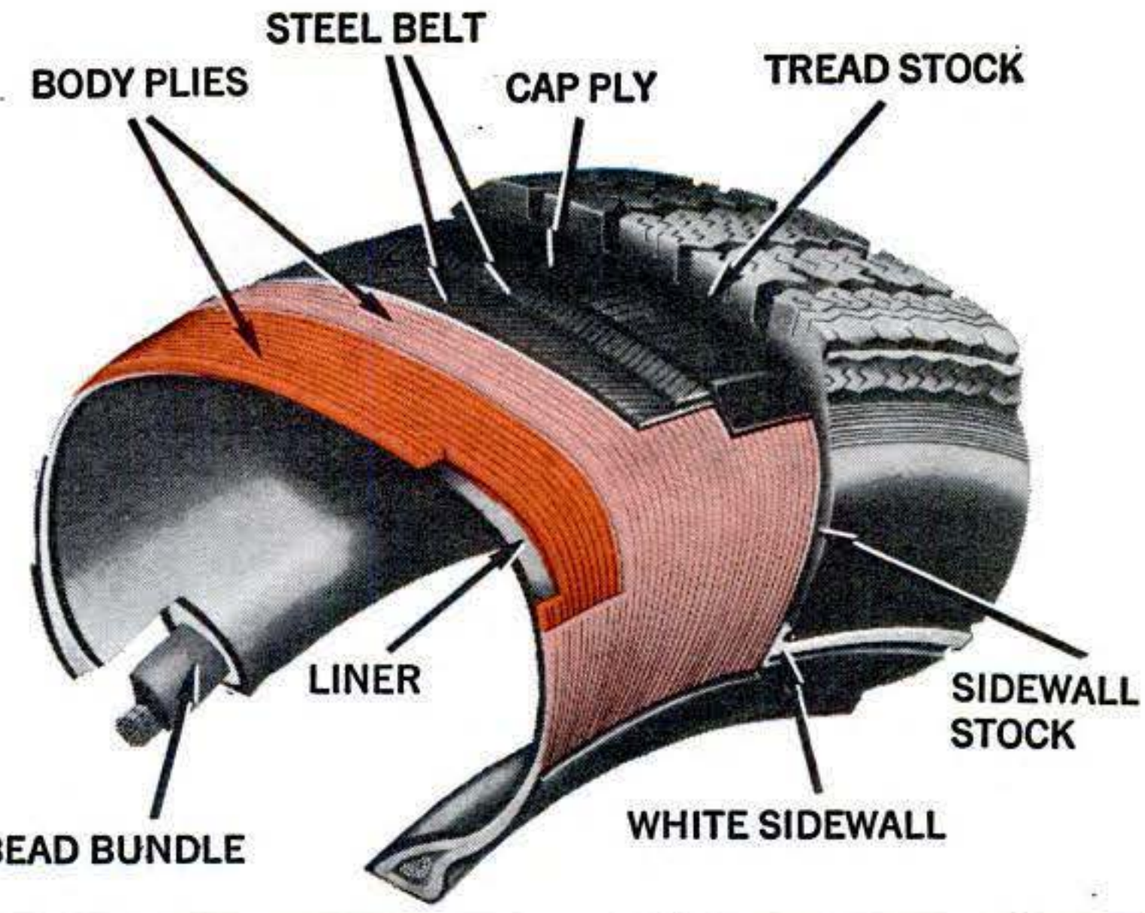
Check inflation pressure. If just one tire is underinflated, the stability of your car is upset, even on a dry road. A rain-slick highway will multiply the danger.

Finally, don't mix radials and other tires on the same car. It may not be much of a problem in dry weather, but you run a greater risk of skidding when it's wet.

More advice. You know enough about slippery roads to give yourself two to three times longer distance to stop. We have published several helpful stories about winter driving in the past. Need more advice on skid prevention and control? Pirelli offers a free booklet: "Wet Weather Driving Guide" (Pirelli Tire Corp., 60 E. 42 Street, New York, N.Y. 10017).

Next year, most models from all auto makers will have steel-belted radials as standard or optional. We recommend them for *all cars,* even older models. PS

And now, a 50-series radial! This is B. F. Goodrich's Lifesaver T/A 50, with rayon carcass and dual steel belts. Tread pattern is designed to fight wet skids.

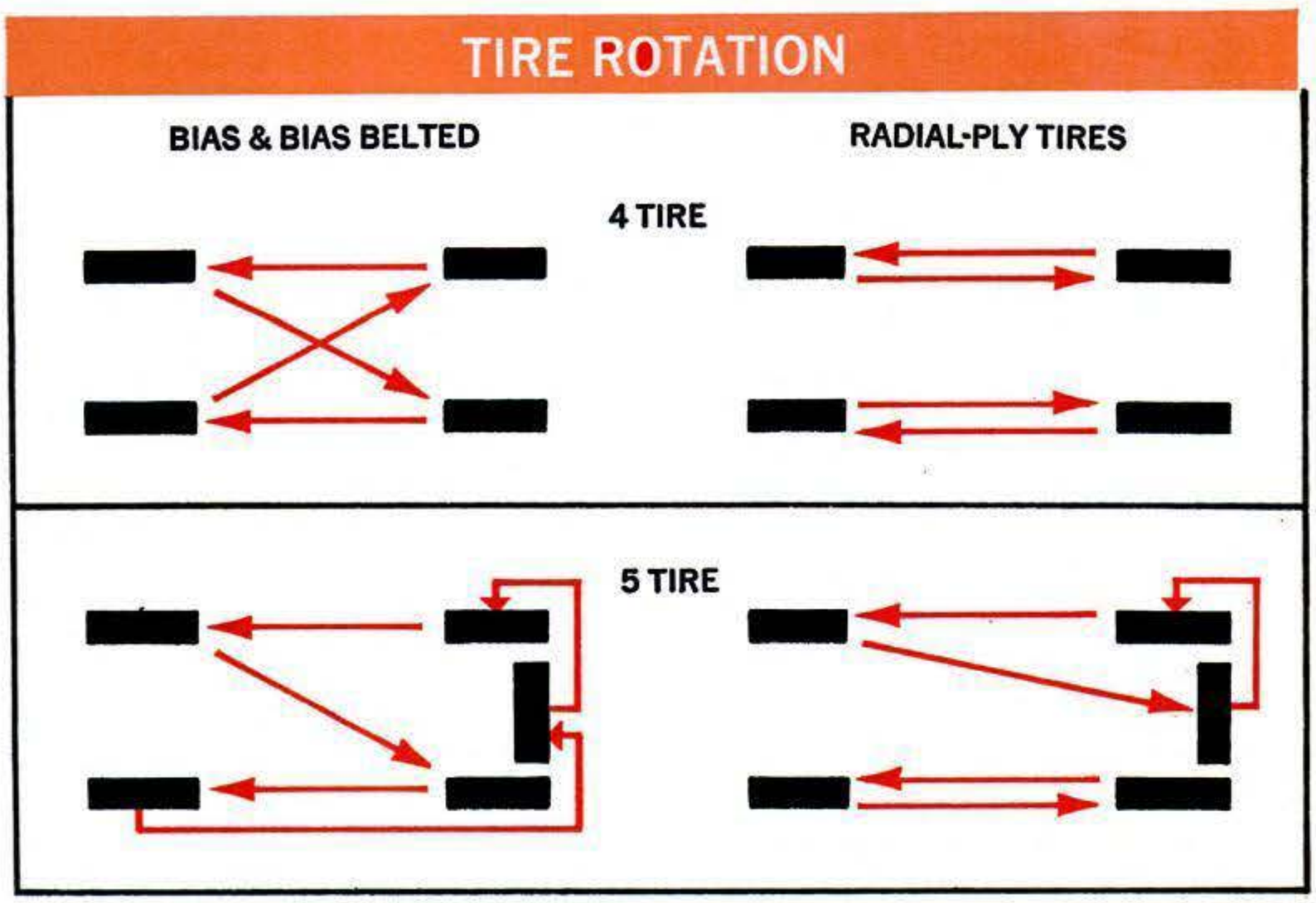


Steel-belted radial tire has more components than other types. A bias-ply tire has nine components, and a bias/belted tire has 12. The radial tire has 20. Cap ply in this Uniroyal Zeta 40M is a nylon layer that keeps steel-belt edges from chafing into the tire's tread stock.

Why Detroit is switching to steel-belted radials

- Most tire makers guarantee 40,000 miles tread life. Steel belt eliminates fatigue factors from tread.
- Resistance to cuts by glass, sharp metal objects, and other road hazards is exceptionally good.
- Ride quality is superior because of the increased impact-absorption capacity of the soft sidewalls. Road shocks are minimized.
- Handling precision and cornering power are doubled, because of the rigidity of the steel belt and the flexibility of the sidewalls.
- Speed capacity is higher, and high-speed endurance superior, because running temperatures are lower (about half, or 100 degrees F less). The sidewalls flex without heat build-up, as the carcass plies do not cross but run radially, and are free to flex without causing internal friction in the tire. Centrifugal force in the tire is restrained, because the belt is inextensible. This is an added safety factor at highway speeds.
- Radials run quieter. Dr. George R. Thurman of Firestone says his tests show that radials run two to three dbA lower than bias-ply tires.
- Fuel economy is improved five to 10 percent, because the belt assures reduced rolling resistance, which means reduced power (and fuel) consumption.
- Squeal suppression is better because the tread never twists in relation to the wheel but is displaced in parallel. This keeps the tread from being rubbed sideways against the road surface.
- Overload tolerance is far superior to other types of tire construction, because of the supple sidewalls and the tire's higher air retention capacity.
- Ridging, when merging or changing lanes is eliminated, because of the stability of the steel belt.

TIRE ROTATION



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Astronomers' Great New Triumph—

EYEING THE STARS FROM

Copernicus, our latest Orbiting Astronomical Observatory, wields a mighty "telescope on wings" to reveal wonders of heavens forever hidden from Earth

By ALDEN P. ARMAGNAC

Since last August, the biggest stellar telescope in space has been circling the earth at 460-mile height. The 32-inch-diameter "eye" rides our unmanned spacecraft Copernicus, largest and last of our Orbiting Astronomical Observatories or OAOs. Protruding solar-power flaps give Copernicus the symbolically appropriate overall appearance of a telescope on wings.

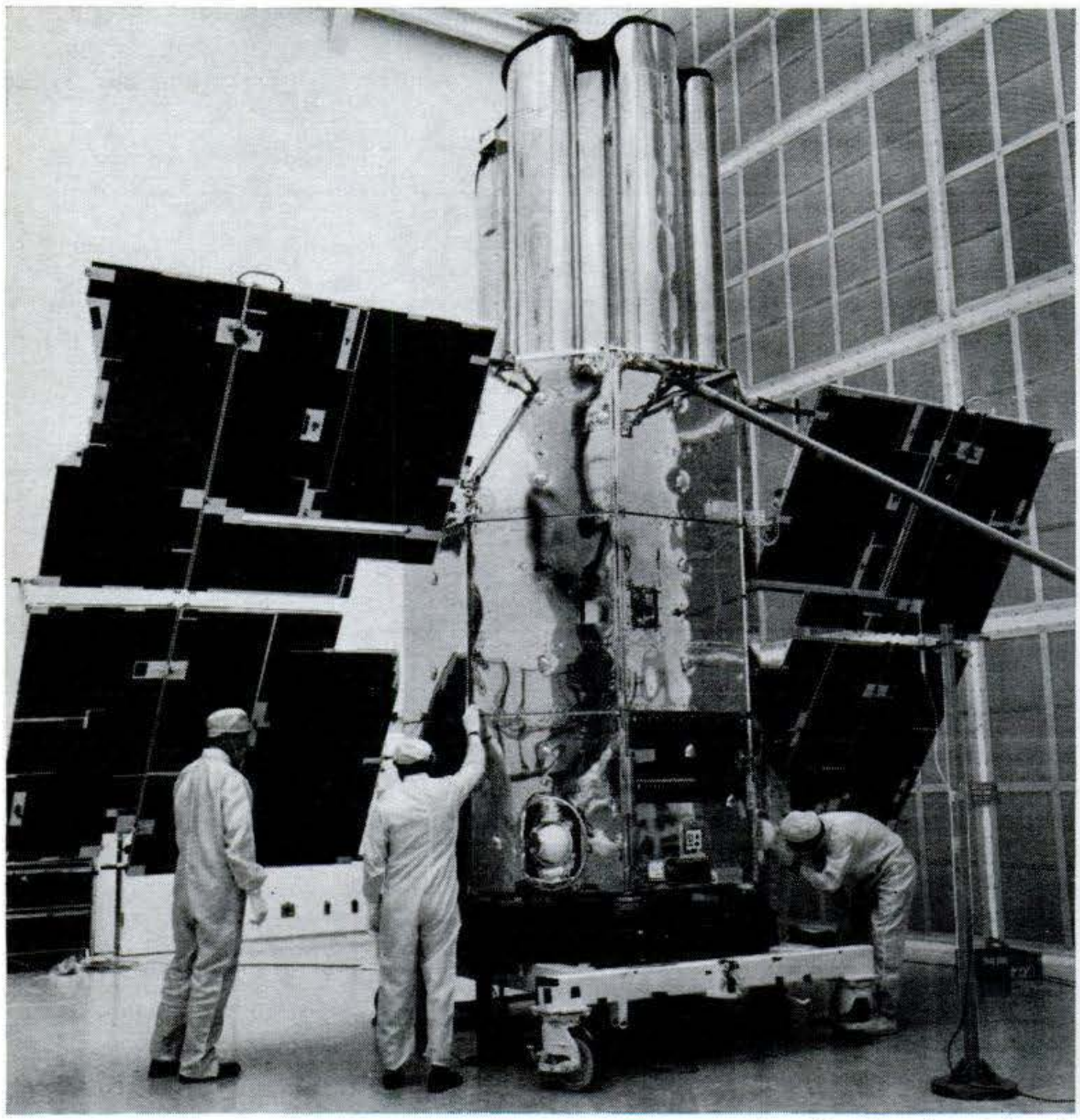
Aimed with fantastic accuracy by remote control, the 10-foot-long, 1000-pound reflecting telescope views the stars by ultraviolet rays that never reach a ground observatory, because they cannot penetrate the Earth's atmosphere. Three small telescopes and a device called a proportional counter, also aboard Copernicus, observe the heavens by X rays —similarly undetectable on Earth. What Copernicus sees, it tells Earth-bound astronomers in a torrent of radio signals.

First public announcement of how Copernicus is doing has just come from Dr. John E. Naugle, NASA Associate Administrator for Space Science, who hails it as a success even beyond original hopes. At last report it had made almost 2000 observations of 92 ultraviolet and X-ray sources in the sky. Studies of galaxies and of the remnants of a supernova were under way. In coming months, several hundred known X-ray sources were to be sky-mapped more precisely by Copernicus.

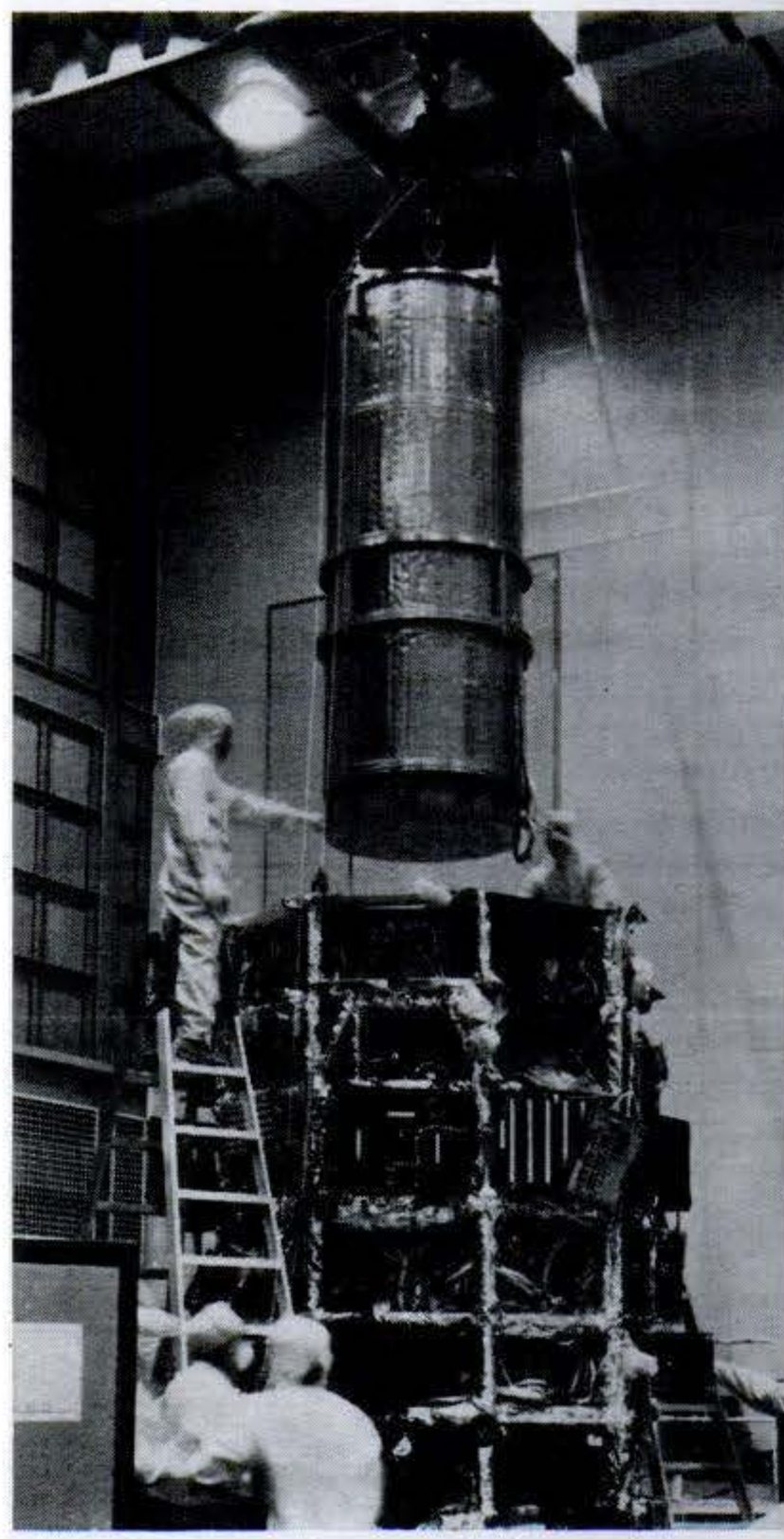
Wonders viewed from space. Observations from satellites in orbit have opened a golden era of discovery for astronomy.

Observatories on Earth can view the stars by only a small part of their radiation: visible light; ultraviolet and infrared rays (invisible but observable, say, by photography) of closely adjacent wavelengths; and radio waves, another window to the heavens, which has been exploited by radio astronomy within just the last few decades.

Now, observatories orbiting above the obstructing atmosphere bring into view the whole gamut of the



Astronomy spacecraft Copernicus, with solar panels installed, nears readiness for successful launch on August 21, 1972. It carries the largest stellar telescope ever put in orbit, for ultraviolet observations—plus X-ray instruments, whose sun shields surround that of the big 'scope at top of photo.



Record-size telescope is lowered into center of spacecraft during assembly. Copernicus views the stars by rays that never reach observatories on Earth.

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SPACE

stars' radiance [chart, next page]. And astronomers are enthralled by wonders they've been missing befcre.

What satellites are seeing. Spectacular hydrogen clouds up to a million miles in diameter have been found to surround comets in ultraviolet observations by OAO-2, Copernicus' predecessor. The discovery supports current belief that a comet's head consists largely of water ice; its evaporation and dissociation in space would explain the huge hydrogen halos.

In May 1972, OAO-2 saw a rare celestial spectacle—the brightest supernova in 35 years, and the first observed from a satellite. From orbit it was an awesome sight. For a short time, the ultraviolet intensity of the exploding star outshone the entire galaxy to which it belonged.

Orbiting observatories are probing

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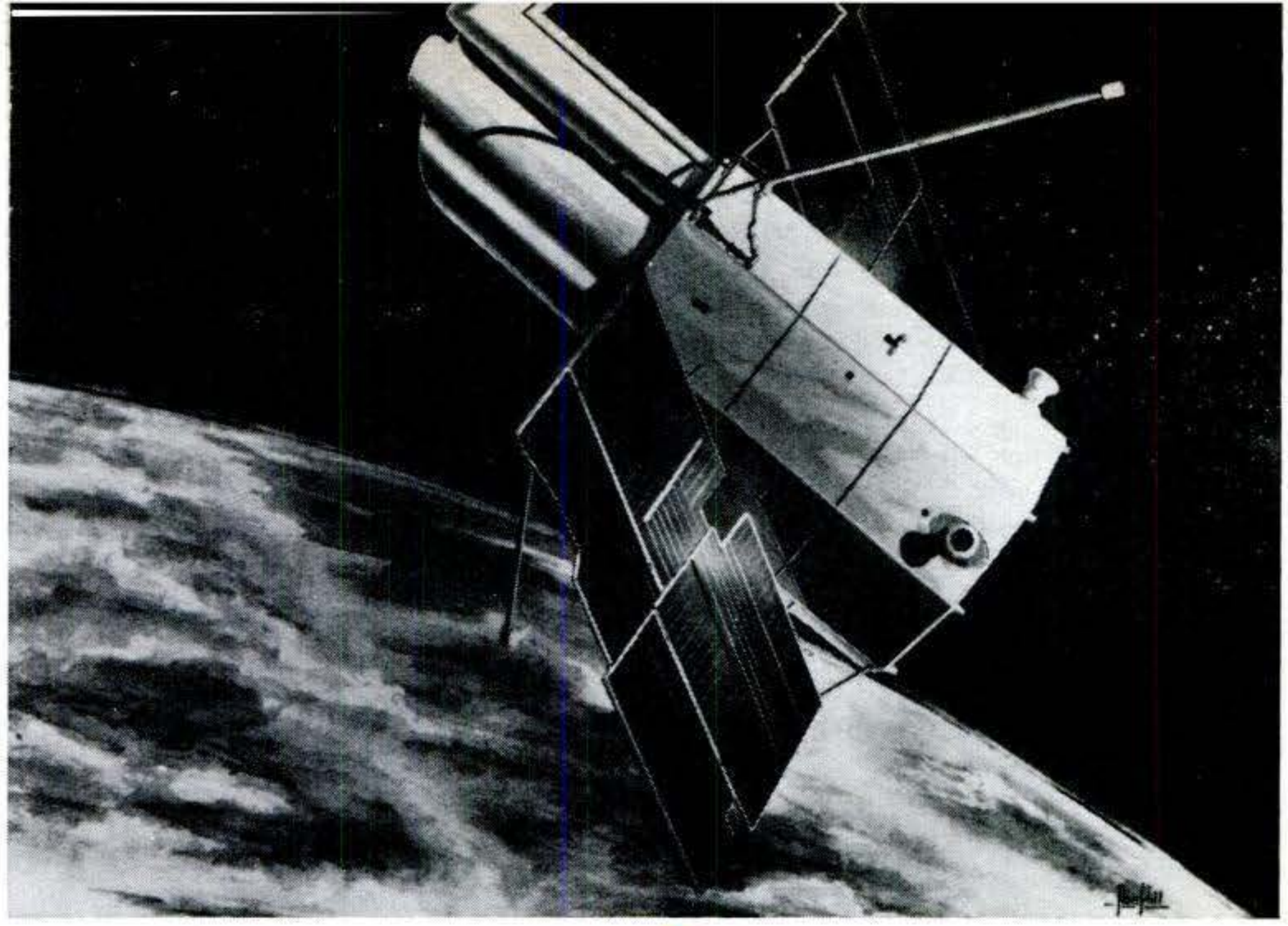
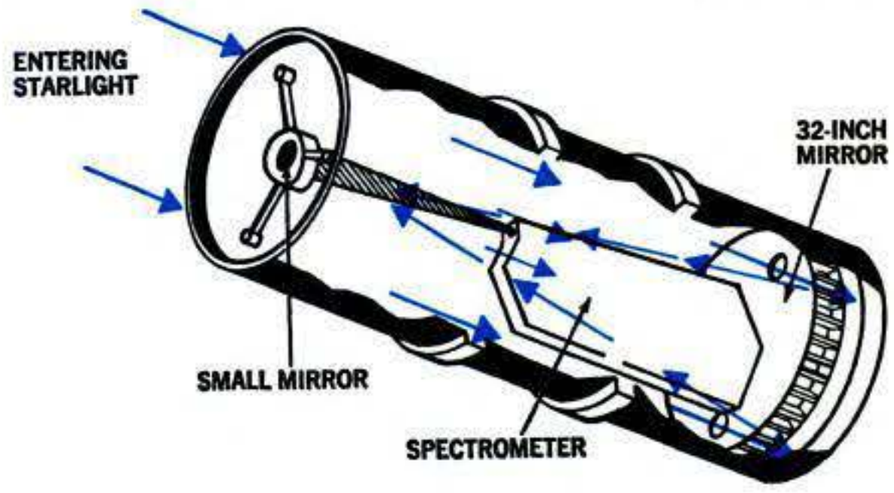
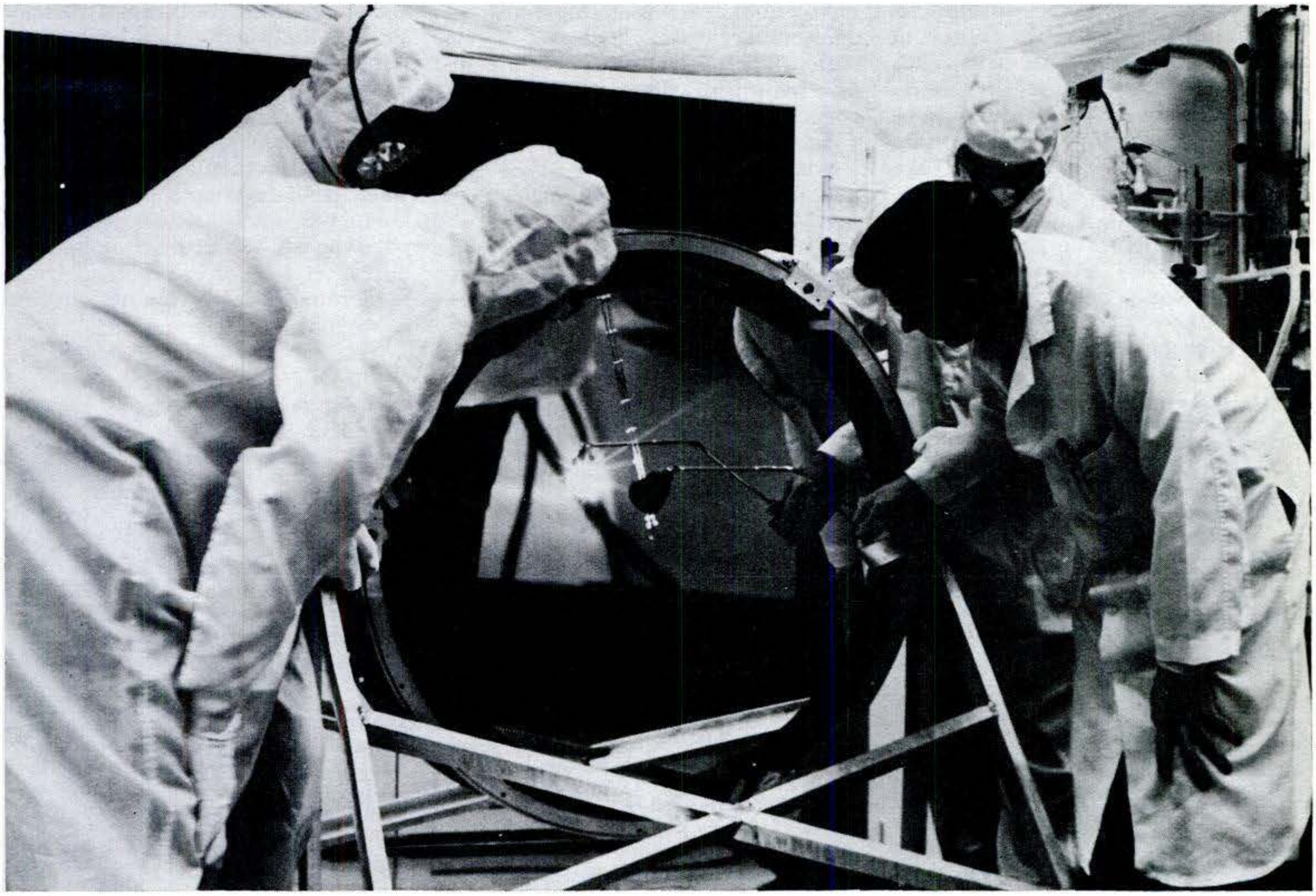


In 460-mile-high orbit, Copernicus points telescope so precisely it could hold in sight a basketball 400 miles away for an hour. Diagram, right, shows design of telescope—of Cassegrain type. Starlight strikes large mirror first, then small one, and enters spectrometer where spectrum is formed and analyzed. Findings, in form of numbers, are radioed to Earth.





Copernicus' great eye, a 32-inch concave mirror of fused quartz coated with highly reflective aluminum, passes exacting trials at NASA's Goddard Space Flight Center before installation in telescope. Quartz has advantage of small thermal expansion and contraction, preserving accuracy of optical elements despite changes of temperature—which is limited to range from -22° to 59° F by multilayered insulation on inner wall of the 10-foot-long, 1000-pound telescope.

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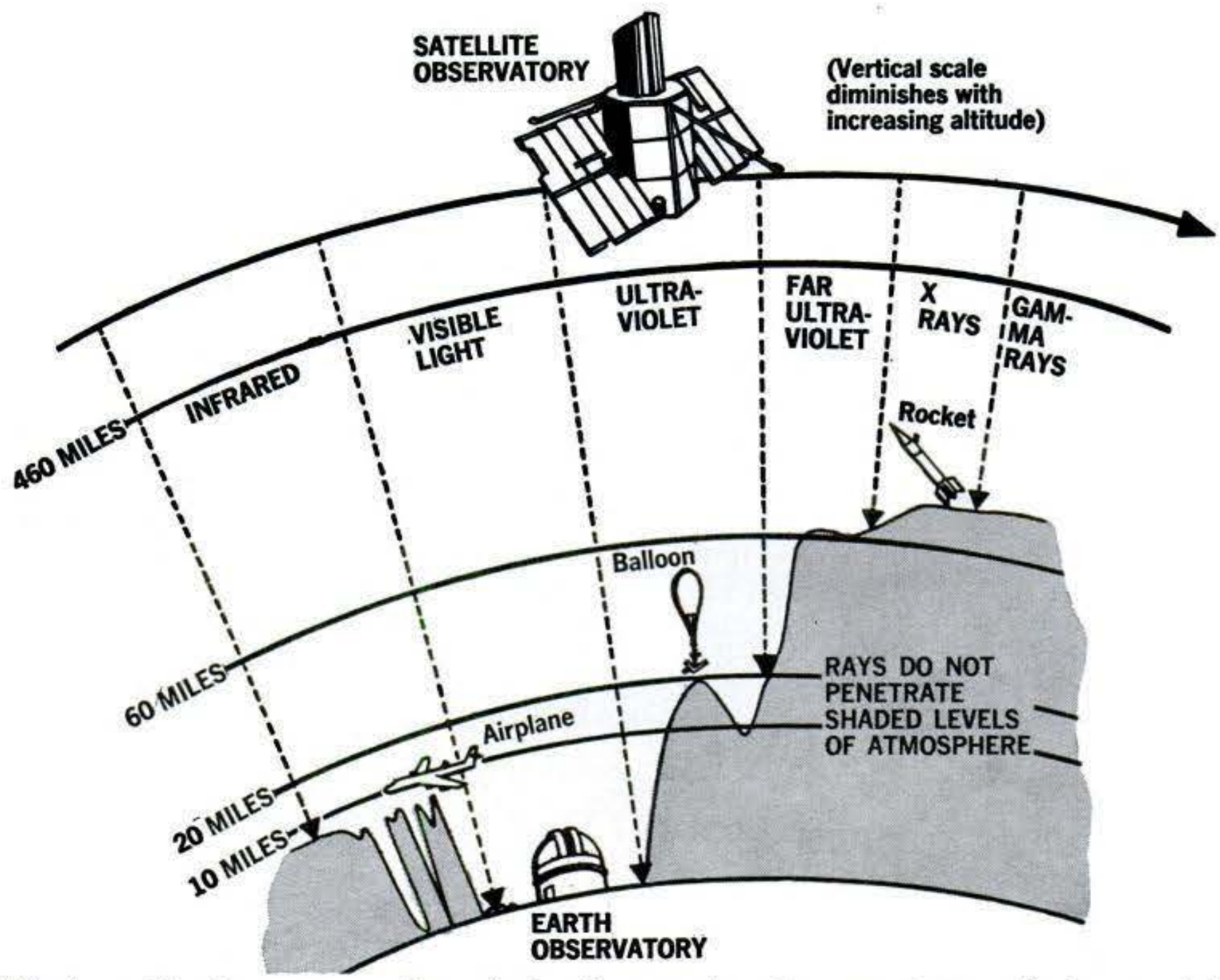


What earth observers miss of stars' radiation, because atmosphere screens it out, is shown by chart. Top of shaded area marks altitude to which various wavelengths penetrate. Airplanes, balloons, and rockets give brief glimpses of rays unobservable below; orbiting satellite has steady view of them all.

the secrets of pulsars—mysterious celestial bodies that release bursts of radiation at precise intervals [PS, June '69]. Pulsars emitting radio waves were the first to be discovered. Now satellites have found pulsars that give off pulses of X rays—like one called Cygnus X-1, observed by an astronomical satellite named Uhuru [PS, Sept. '71].

Satellites also are telling what's in interstellar space by noting the wavelengths of starlight absorbed in passing through it. A surprise Copernicus finding is the abundance of deuterium or "heavy hydrogen"—one molecule in every 200—in interstellar hydrogen clouds. By current theory, the deuterium in the universe should have been more depleted, in stoking the stars' nuclear-fusion furnaces. Now, it's said, this theory may need to be revised.

Little ones, big ones. Star-gazing satellites successfully launched to date include a variety of U.S. types. A series of three Small Astronomical Satellites began in 1970 with the world's first X-ray astronomy satellite, Uhuru. The second of the series has since been orbited; the third and last is scheduled for orbiting in 1975.

But the Orbiting Astronomical Satellites, built for NASA by Grumman, are the "big guns" of satellite astronomy. Two out of the series' four have gone into successful operation, escaping mishaps that disabled the others. OAO-2, launched in 1968 and designed for one-year life, actually operated until February 1973. Its all-ultraviolet equipment included four 12-inch telescopes.

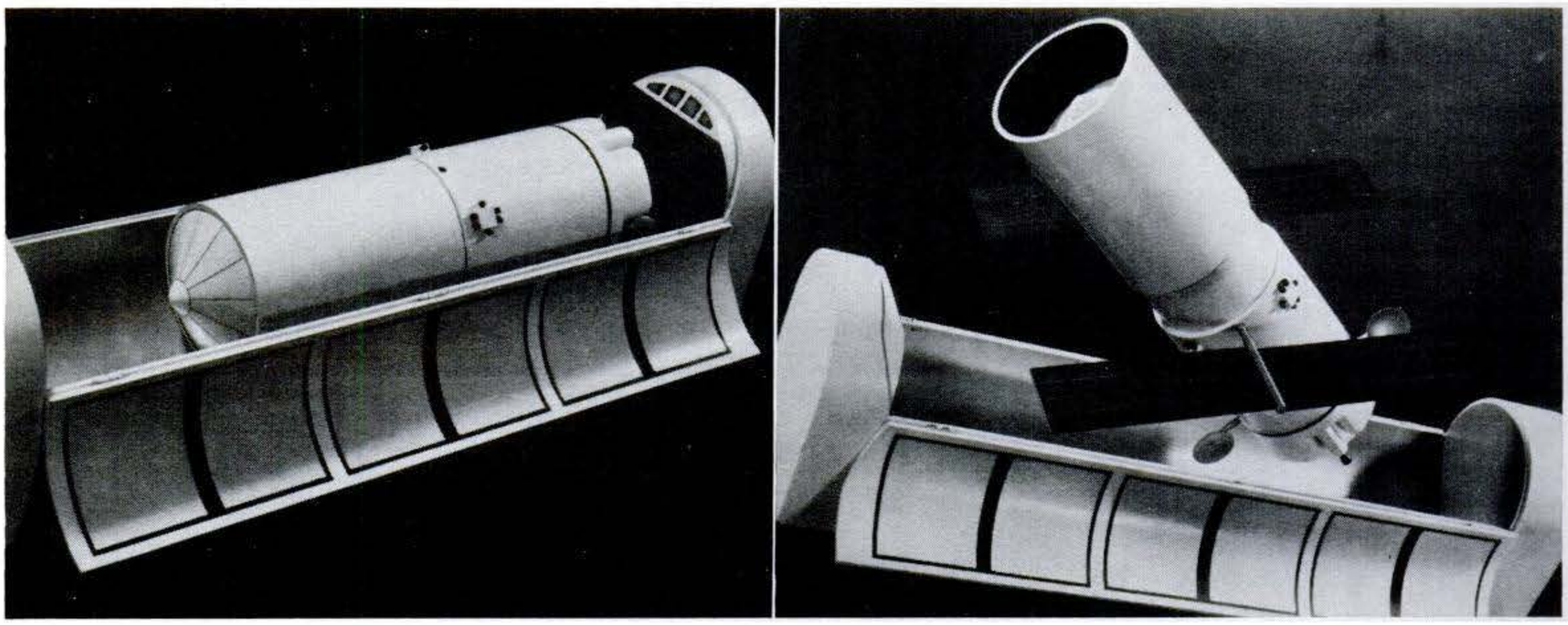
Copernicus is the most. It's tops in size, and in the fantastic precision of aiming its telescopes.

Its weight of 4900 pounds makes it the heaviest stellar observatory ever launched. Through its center runs its great ultraviolet telescope, surrounded by its X-ray gear. Fixed in their mountings, all telescopes are pointed at targets by maneuvering the whole spacecraft with the help of attitude-controlling flywheels, jets, and gyros.

Imagine an object the size of a basketball 400 miles away from the satellite in space. Copernicus is designed to train its biggest telescope so accurately as to find such a pinpoint target—and hold it steadily in view for up to an hour. In actual operation it has lately been reported to be doing even better.

How Copernicus does it, even when condensed in highly technical language, takes a 64-typewritten-page description of its complex "stabilization and control system" to tell in detail. A vastly simplified summary may give some idea:

[Continued on page 146]



Large Space Telescope with huge 10-foot-diameter mirror is tentatively planned to be orbited by Space Shuttle in early 1980s. Drawings from NASA visualize it stowed in Shuttle for launching (left), and being deployed in orbit (right). Besides observing stars' spectra, it would be able to take high-resolution photographs of celestial objects.

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A/C for '73: More Cool, Less Current

High-efficiency units can help ease the energy squeeze this summer—and shrink your cooling bills, too

By DOUG GARR

"Save-a-watt," "Watt-watcher," and "Watt-wise" are themes you're likely to see if you're shopping for a room air conditioner this year. The reason: Air conditioners are notorious for gobbling up lots of electricity, and utility companies sometimes cannot meet the peak demands for power during summer heat waves. In addition, there's all the brouhaha about the energy crisis.

There's something you can do about it—both to save energy and get maximum cooling for your buck.

- Get an efficient model if you're buying a new unit.
- Make sure your units operate at peak efficiency.

It's no secret that manufacturers are being pressed by government and utilities to make more efficient, less power-hungry air conditioners. Last year in the Office of Emergency Preparedness' report, "The Potential for Energy Conservation," one measure cited to save fuel was to "improve the efficiency of furnaces and air-conditioning units."

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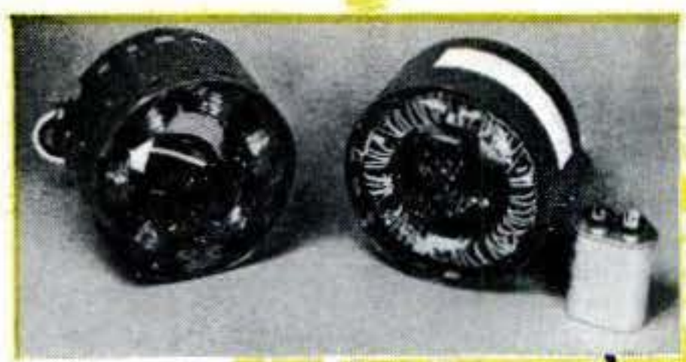
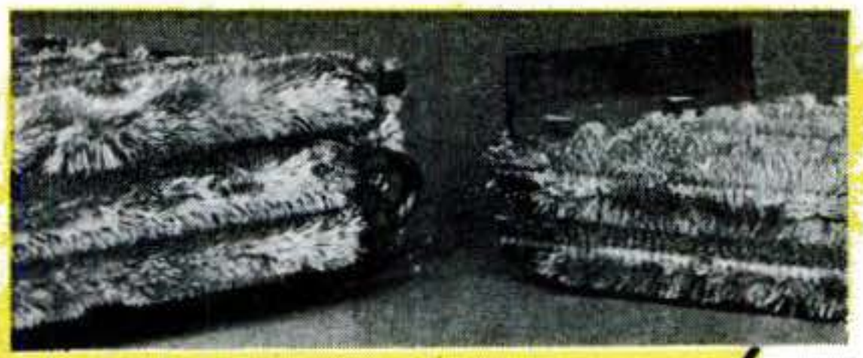
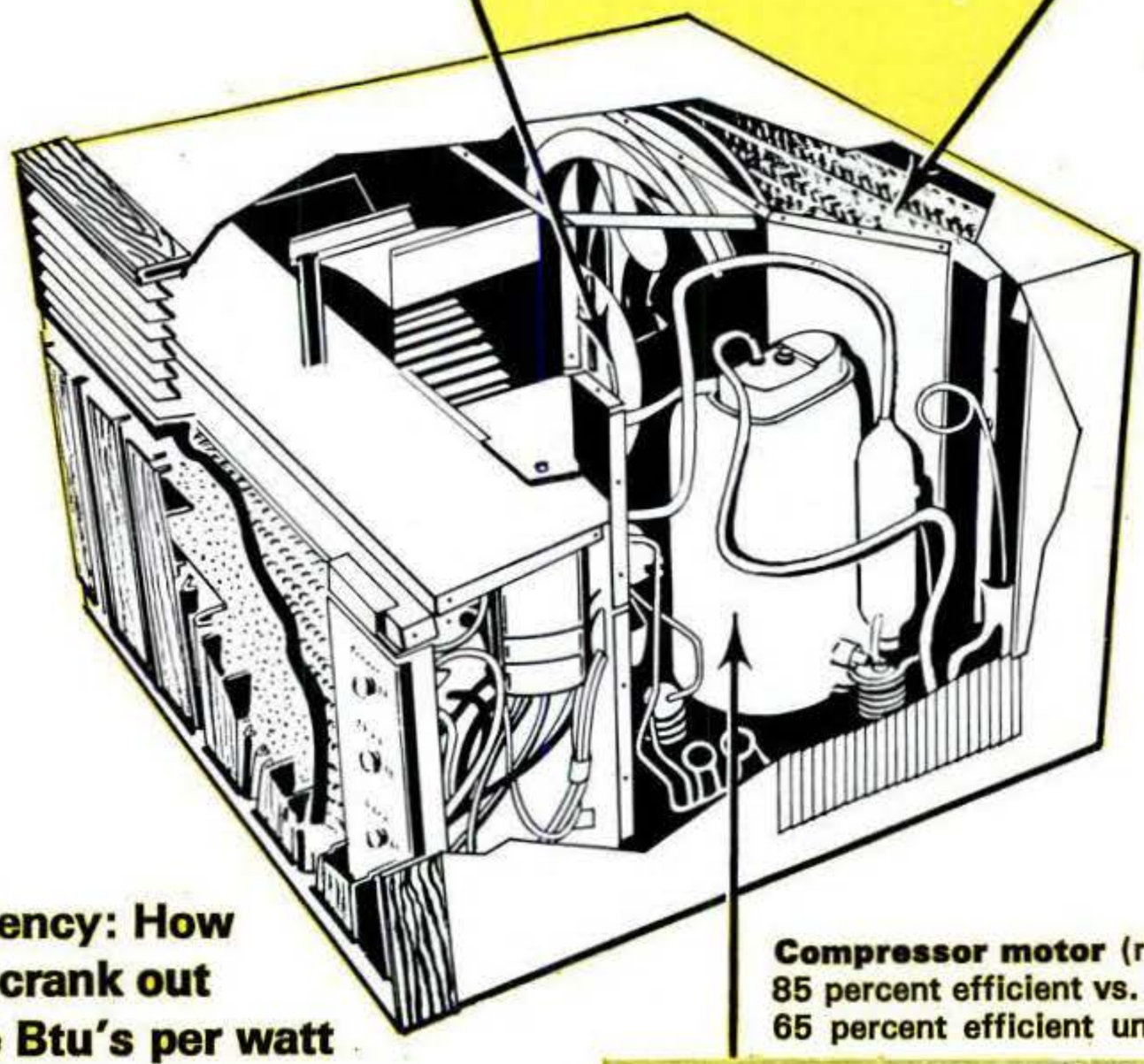


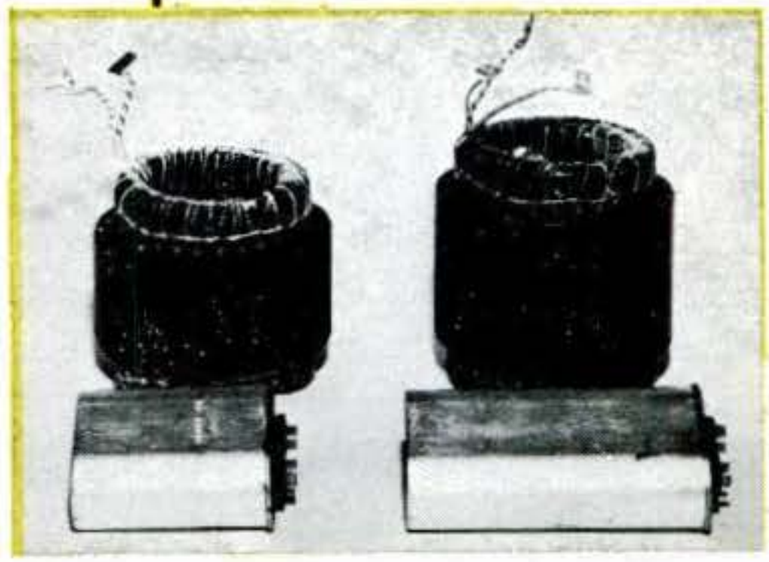
Low-efficiency fan motor (right) has fewer wire-windings, needs extra capacitor.



High-efficiency spine fin cooling coil is heavier, has extra row, more surface area.



Compressor motor (right) is 85 percent efficient vs. lighter, 65 percent efficient unit.



Efficiency: How they crank out more Btu's per watt

Three factors in room-unit design affect efficiency, or how much power an air conditioner uses for every Btu it cranks out: 1, refrigerant cycle; 2, air-flow capacity; 3, electrical efficiency.

The refrigerant cycle is most important. Heat flows to a low-pressure liquid in the evaporator (inside the room) which then vaporizes, and is forced by the compressor into the condenser (outside). High pressure causes vapor to condense and give up heat outside.

While the refrigerant is alternately vaporizing and condensing, the temperature changes, from a high of about 130 degrees in the condenser to about 40 degrees in the evaporator—a difference of 90 degrees. Temperature is directly related to pressure. To reduce this temperature difference to, say, 70 degrees (120 degrees in the condenser and 50 degrees in the evaporator) would make the cycle more efficient. Less pressure would be needed to pump the refrigerant, hence less power would be needed for the compressor. To reduce the temperature difference, engineers have to design condensers and evaporators with bigger surface areas. Result: bigger, more expensive coils.

Air-flow circuit efficiency. The power it takes to drive the fan motor can vary as much as 250 watts, from a low of 50 to a high of 300. Naturally, freer air flow through the cooling and heating surfaces means lower wattage and higher efficiency. Here the engineers can increase the spaces between heat transfer surfaces to optimize efficiency. The bigger the surface, the more space (and air flow) they can get.

Electrical efficiency. Low-cost, low-efficiency fan motors operate at about 25 percent efficiency. High-efficiency motors, which need more copper and iron (hence heavier, larger, more expensive) are about 65 percent efficient.

When they're all through, you get some advantages and disadvantages. High-efficiency units have lower operating costs and lower power consumption. But they also have higher initial cost, larger size, and greater weight.

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"It's best to undersize a unit slightly rather than oversize it"

The industry's trade agency, the Association of Home Appliance Manufacturers (AHAM) has already acted. This year, its annual directory of certified units will contain an additional statistic: the "energy efficiency ratio," already known in some cities as the EER number. EER may become just as important as the Btu did some years ago when it replaced horsepower and tons as a yardstick to measure cooling capacity.

There's already talk of electrical associations in at least three cities, New York, Los Angeles, and Philadelphia, requesting or requiring makers to identify the EER on room units sold in those cities, in addition to the other specifications. GE, Sears, and Friedrich have already announced they will voluntarily provide the EER for *all* their room units.

If your dealer doesn't know the EER, you can easily figure it out yourself. Divide the number of Btu's of cooling capacity by the unit's rated wattage (Btu's/watt). For example, a 5000-Btu unit that uses 800 watts has an EER of 6.25. Another 5000 Btu unit that draws only 650 watts has an EER of 7.7. Naturally, the higher the EER, the less electricity you'll use. But you pay for that extra efficiency in initial cost. The higher the EER, the more expensive the unit.

Efficiency—do your arithmetic

Is it worth the extra cost to buy the high-efficiency unit? You can't judge by the energy efficiency ratio alone. Since the price difference on a room unit can be as much as $30-$50, it pays to do a little arithmetic.

For example, let's take two typical 115-volt, 8000-Btu room units. The first uses 1375 watts per hour and costs $200; the second draws only 860 watts, but costs $240. The EER of the first model is 5.8; the second, 9.3 (which is 60 percent more efficient than the cheaper model). Assume, too, that you live in Washington, D.C., where you expect to use your unit about 1000 hours this summer (close to the national average). At 2.3 cents per kilowatt hour (also close to the national average), it'll cost $31.63 to run the low-efficiency unit, and $19.78 to run the high-efficiency unit. Saving nearly $12 per summer in operating cost, you'll have recovered the extra investment on the more expensive unit in 3.4 years. Savings should be more significant when you consider that electric-rate hikes will soon be commonplace. Even if you use your unit only half as much, you'll start saving money in about six years.

Spend to save? Yes; while the more expensive unit may not entice you in the showroom, it can save you money in the long run in reduced electric bills. Just how long the long run is depends on the cost of electricity in your area, the number of uncomfortable days (hour usage), and the cost comparison on high- versus low-efficiency units in the size you need.

Just how long should it take before you get your extra initial investment back? Obviously, the 3.4 years in our example is pretty good. But it's a lot like amortizing the cost of a car, only harder because it's often over a longer period of time. Repair costs and operating costs are bound to increase. If you live pretty far north and use a unit only 150-200 hours per summer, it might take 20 years to break even on some cost comparisons. (The map on page 81 shows quite a difference in operating costs between the extreme north and south in the U.S.) Since the life span of an air conditioner is about 10-15 years, it would probably pay to get a cheaper unit in that case.

Predicting hour-use is a problem, because some people run their air conditioners all day, some only a half day or less in a given area. Surprisingly, there's no last word on what's better and cheaper. On one hand it's better to leave it running all day, even if you're not at home. The GE experts contend it's difficult to cool a room when you get home on a hot day. "From a comfort standpoint, you're better off to let the unit run all the time," says John Slattery, GE's manager of engineering on room units. "The compressor really has to work to pull all the heat out of the furniture, draperies, and rug," Slattery says. And the utility companies don't want everyone turning on their units at 5:00 pm on the hottest day of the year. That's what causes their equipment failures.

But why pay for cooling when you're not home? Is there some way to compromise between running your air conditioner half the time and all the time? Ed Douglas, of the Electrical Energy Association recommends the timers that automatically turn the unit on two hours or so before you get home. When you do arrive you'll be reasonably comfortable. If the morning newsman tells you it's going to be a 95-degree scorcher, set the thermostat high, about 80 degrees. When you get home you'll be surprisingly comfortable. Then you can lower the thermostat gradually without having to cool a hot-box. You'll be doing save-a-watt duty, too.

The lower you set your thermostat, the more power you'll use. Try and get by with the highest comfortable setting. Ed Douglas says, "Cooling your house to 75 degrees, instead of 80, could take as many as 50 percent more cooling hours." That's a steep addition to your electric bill.

Some homes cool easier than others

Besides buying a high-efficiency unit and operating it properly, you can also save a few bucks by making your home efficient for cooling. Two rooms exactly the same size could vary as much as 1000 Btu's in capacity needed, depending on lots of important variables:

- Sealing the windows. Windows are a trouble spot when you're trying to retain cool or warm air. First, make sure that no outside air leaks into the room

The 20 most efficient room units for '73

Manufacturer	Btu's	Weight	EER
Westinghouse AS114N7K	10,500	209	12.2
Friedrich SM10310	10,300	185	12.0
Philco AH10B3	10,000	199	11.6
Fedders ASL10E2G	10,000	183	11.5
Carrier FA0101	9,500	145	11.1
Amana 6152J	14,500	235	10.5
Friedrich SSO9010	9,000	171	10.5
General Electric AGFE809FA	9,000	140	10.5
Hotpoint AHMQ709FB	9,000	145	10.5
Kelvinator K3931QD	9,000	122	10.5
Comfort-Aire WK975	9,000	136	10.4
Gibson M72901KS	9,000	122	10.4
York RC90	9,000	136	10.4
Chrysler HO910	9,000	128	10.3
Fedders ASL09E2G	9,000	177	10.3
Chrysler M1420H	14,000	202	10.2
General Electric AGDE914AA	14,000	166	10.2
Hotpoint AHMQ714AA	14,000	165	10.2
Philco AH14B1	14,000	198	10.2
Emerson 14CH4A	14,000	179	10.1

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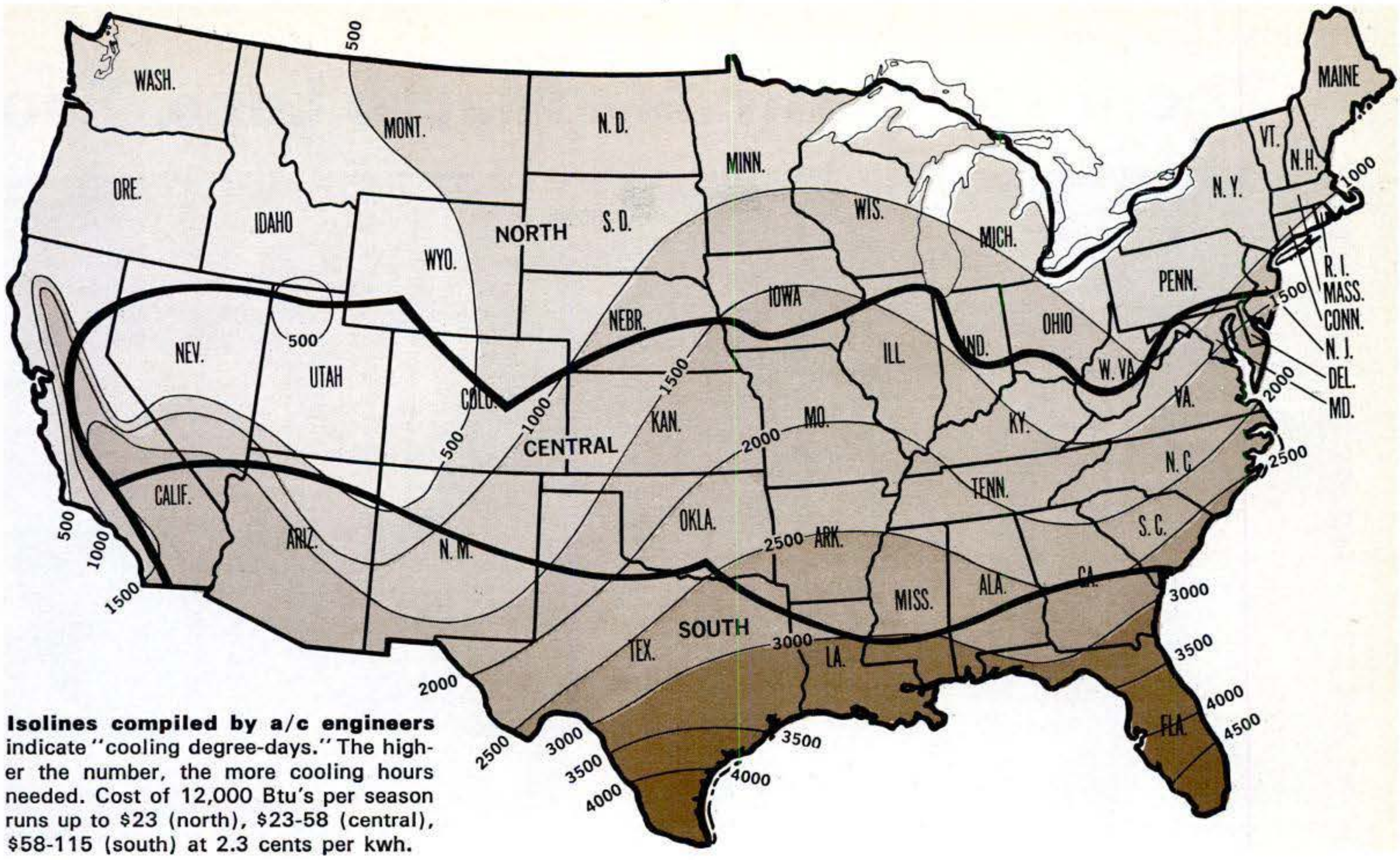

Isolines compiled by a/c engineers indicate "cooling degree-days." The higher the number, the more cooling hours needed. Cost of 12,000 Btu's per season runs up to $23 (north), $23-58 (central), $58-115 (south) at 2.3 cents per kwh.

you're cooling. Are all the windows properly glazed and sealed? Draperies, blinds, and window shades are a good idea. They should be light in color, yet opaque. You may even want to try silver-foil reflectors on the outside if the exposed windows are in the late-afternoon sun. Almost any shading can reduce heat gain through the windows up to 50 percent. Leave the storm windows up during the summer for extra insulation. Outside awnings, provided they're designed so as not to trap hot air in the window area, will also keep sunlight off the windows.

- Insulation adequate? This is usually easiest to cope with when you're building a new house. The thicker the insulation—especially in the ceiling—the better off you'll be. Six-inch-thick thermal insulation is about the best you can do in the ceiling, and beefing up the walls to three or four inches will make a big difference. How much you should add before buying air conditioners depends on whether lower operating costs will offset the additional outlay for insulation. Usually it will pay after several years.
- Ventilate your attic. This is extremely helpful, especially if your upstairs is warmer than the ground floor. A hot attic, says Ed Douglas, is "like a radiant heating system working against your air conditioners." They work against your cooling most when the sun beats down continuously on a dark roof. (Your attic can get 40 degrees hotter than the outside temperature.)

Better than natural ventilation is a fan to exhaust the stagnant air in the attic, thus keeping attic air from warming the rest of the house. It's best to mount the fan up high where the hottest air is. Operating costs are low; typical fan wattage is 400.

- Roof absorption. Remember, your roof absorbs the sun's heat. If your house is in a grove of trees, it's going to be that much cooler than that of your neighbor's down the block, protected only by a rose bush. If you have to repaint, keep it a light color.

There are other things you can do to keep your house cool. Keep the flue on the fireplace closed. Operate the kitchen exhaust fan only as long as you need when cooking. Keep electric-light and appliance use to a minimum. You'll be surprised how much this helps. One source estimates each kilowatt of energy used for lights and appliances converts to heat at the rate of 3412 Btu's per hour. Also, cooking, showers, and washing add another 1000 Btu's of heat per hour.

The wrong size unit can spell trouble

More important than any efficiency is properly sizing the space to be cooled for the right capacity. You'll be uncomfortable and probably be wasting electricity as well. Here's why:

First, remember that air conditioners do more than cool, clean, and circulate the air in your home. They are also excellent dehumidifiers, removing several pints of water from the air every hour. High humidity is as much a part of the comfort index as temperature. "People don't always react to temperature," says John Slattery. "You can get awfully uncomfortable if the temperature is a chilly 70 degrees and the relative humidity is 70 or 80 percent. You'll be cool but clammy." An oversized unit won't do the dehumidification job that a slightly undersized unit does, because the compressor will be cycling off more often—cooling before it can properly remove water. Dehumidification is based on removing water over a long period of time. The longer the unit's running, the better.

"It's best to slightly undersize a unit rather than oversize it," says Slattery. Only if you live in a very hot, dry climate should you slightly oversize an air conditioner. Otherwise, don't let a salesman talk you into it. If your calculated load is 11,000 Btu, and all he has is a 10 and 12, buy the 10.

Many manufacturers have charts to estimate the load you'll need for a given room. A most comprehensive one is AHAM's. Their cooling-load estimate is detailed with

[Continued on page 172]

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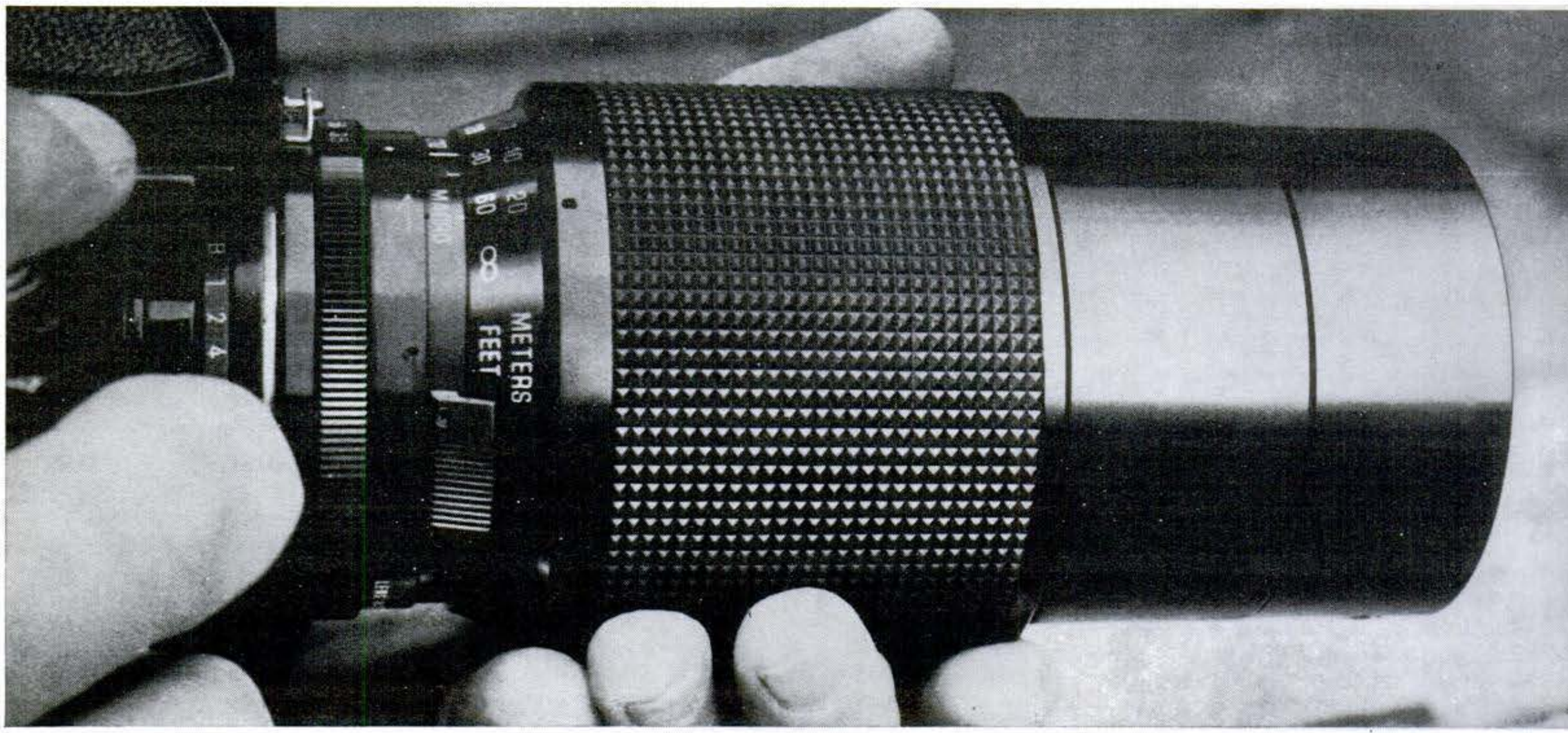
PERSONAL-USE REPORT

Zoom Telephoto Is a Macro Lens, Too



A comfortable handful, the new Series 1 70-210mm f/3.5 Vivitar zoom lens is 6 1/8 inches long, weighs 29 ounces.

Test of material involved brushing it onto block standing in water, covering dry, damp, and underwater surfaces. Coverage was equal on all three areas. Kit (under $10) mixes up to cover about 40 square feet. It's made by Ditrek Corp., 11 So. Fullertone Ave., Montclair, N.J. 07042.

Adding sand to disPatch has two advantages: It makes a first-rate patching mortar (above, left), or when mixed 1:3 increases coverage and fills textures.

PERSONAL-USE REPORT

New Epoxy Masonry Sealer: You Can Apply It Under Water

Maybe it was last year's heavy rains that caused it—a burst of action among producers of basement waterproofing materials. One of the newest is called disPatch, a two-part epoxy sealer with one striking advantage: It works under water. In fact, industrial users have sent it down with scuba divers to make underwater patches in such things as sunken ducts.

What does this mean to you? You don't have to wait for a basement-leak area to dry before you go at it with sealant. You can use the wet areas as a guide to exactly where the leaks are.

Another feature that makes disPatch handy is its mixability with sand. Add sand to the mixed disPatch until you get a mix of mortar consistency. Then trowel it in place. Adhesion is fantastic, and so is resistance to cracking.

Sand provides another advantage. Mix it into the epoxy at about one part sand to three parts liquid and you have a waterproofing brush-on that fills rough textures and gives the effect of two-coat coverage in a single coat.

One thing disPatch won't do is combat running water. In actively flowing situations, it washes away. To handle active leaks, first use hydraulic cement [PS, Sept. '72] to cut off the flow. Then complete the waterproofing and color coat with disPatch.–*Jackson Hand*

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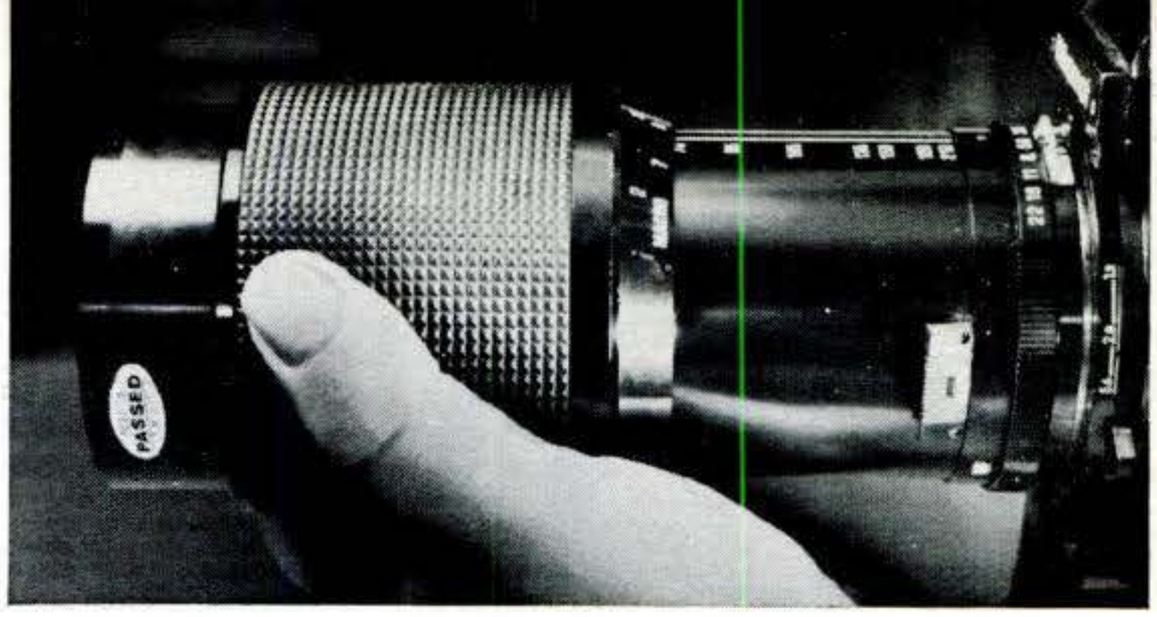
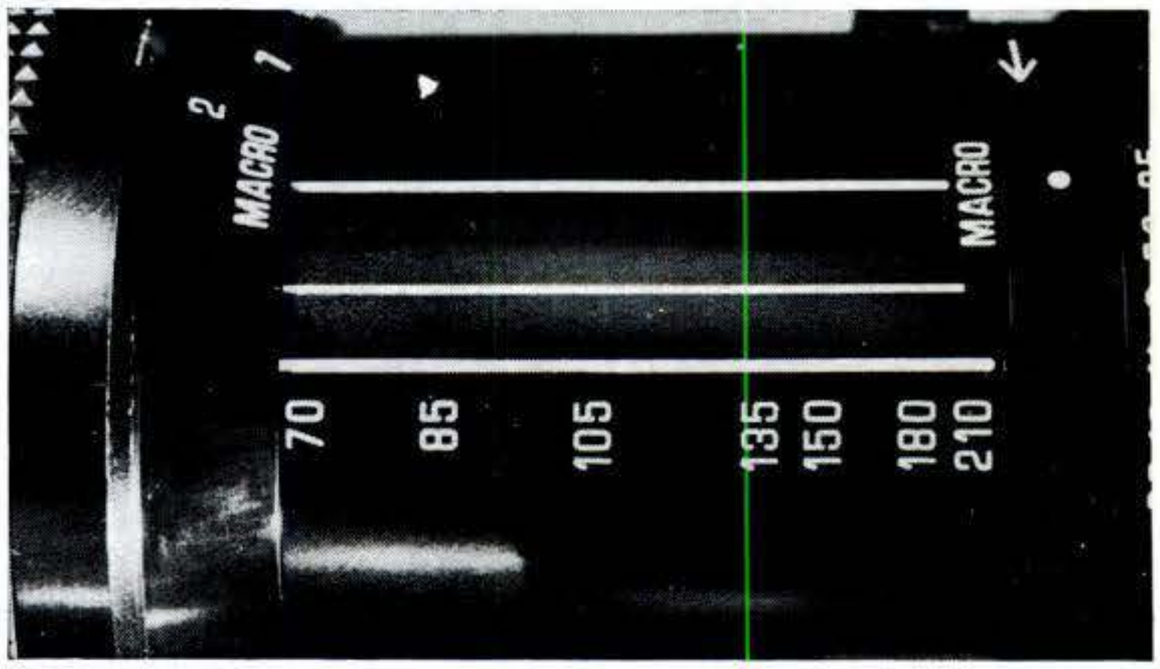
The day when the zoom lens will replace a packet of single-focal-length lenses on 35mm SLR cameras—as it has on most 8mm movie cameras—may be a lot closer with the introduction of the new Vivitar Series 1 70-210 zoom lens. It does two things: It zooms from a moderate telephoto 70mm to an extreme 210; and it works as a macro (close-up) lens, with an image/object ratio of 1:2.2. At all zoom focal lengths that we tried, results rivaled those of high-quality single-focal-length lenses; and in macro use, it produced pictures approaching in quality those of my expensive single-purpose macro lens. All in all, this zoom lens can capably replace several standard lenses in your camera bag.

Its design is unique. The single sliding collar both changes the focal length (as you move it back and forth) and focuses the lens (as you turn it). To change to the macro mode, you bring the collar back to the 210 mark, squeeze a button, and turn. Now the two "zoom groups" of lens elements, which normally move to change the focal length, are used for close focusing. You slide the collar (and the lens groups) back and forth until the image is sharp. The lens can focus on objects from approximately 80 inches away to as close as three. (Non-macro minimum focusing distance is 6½ feet.)

We fired the lens side by side with a fancy-name zoom costing 50 percent more. The Vivitar gave comparable results in every respect. And, of course, it offers a bonus in close-up capability. Price? Around $400. *–Everett H. Ortner*



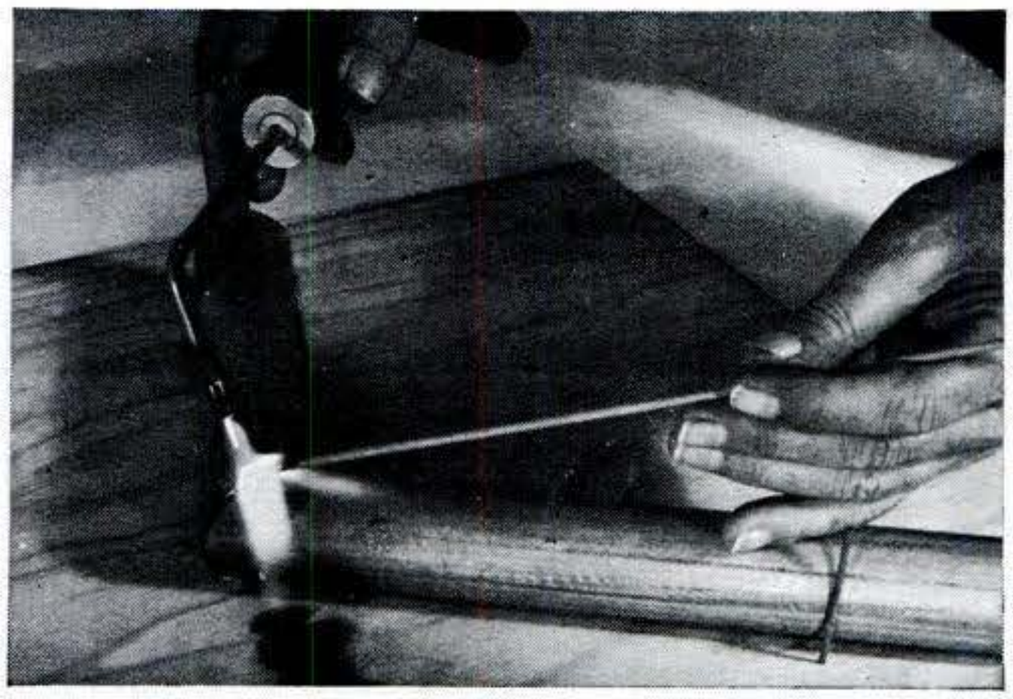
With collar forward, lens is at 70mm—moderate telephoto. PS pre-production test lens had hood; production ones don't.



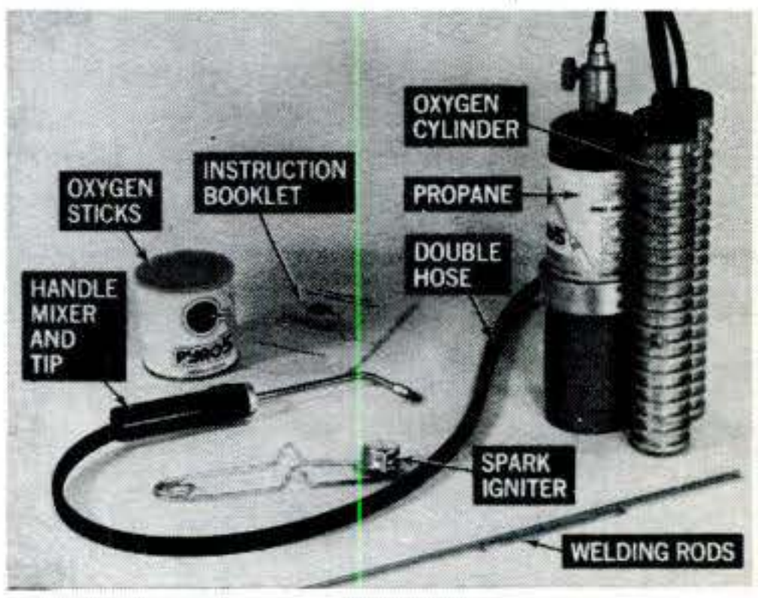
In macro mode, you focus by sliding collar back and forth, keeping "macro" lettering on collar and barrel lined up.

PERSONAL-USE REPORT

A Hot Little Welding Torch

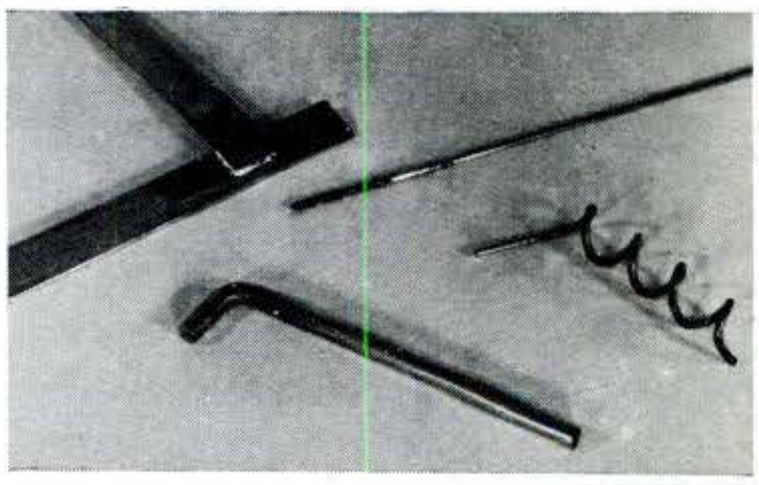


Joints on heavy tubing were no problem for the Pyro 5. Welding goggles are, of course, required.



Complete kit costs $39.95. Spark igniter is for torch, not for lighting oxygen sticks, which require wooden matches.

The oxygen sticks drop into canister after being lit at red end. Put cap on fingertight — oxygen flows immediately.



Test jobs include welds on 1/8-inch strap, bend in ½-inch rod, coiling of ¼-inch drill rod, and making extension bit.

It's almost small enough to carry in your pocket, yet this new Pyro-5 torch behaves impressively in a variety of welding, brazing, and soldering situations. It works by burning a mixture of propane and oxygen. The propane comes from standard small cylinders. The oxygen comes from solid sticks you ignite and drop into a special canister. (The sticks are composed of an alkali chlorate, a fuel, catalysts, and binders. Light one and the fuel burns, generating enough heat to break down the alkali chlorate into oxygen and a salt.)

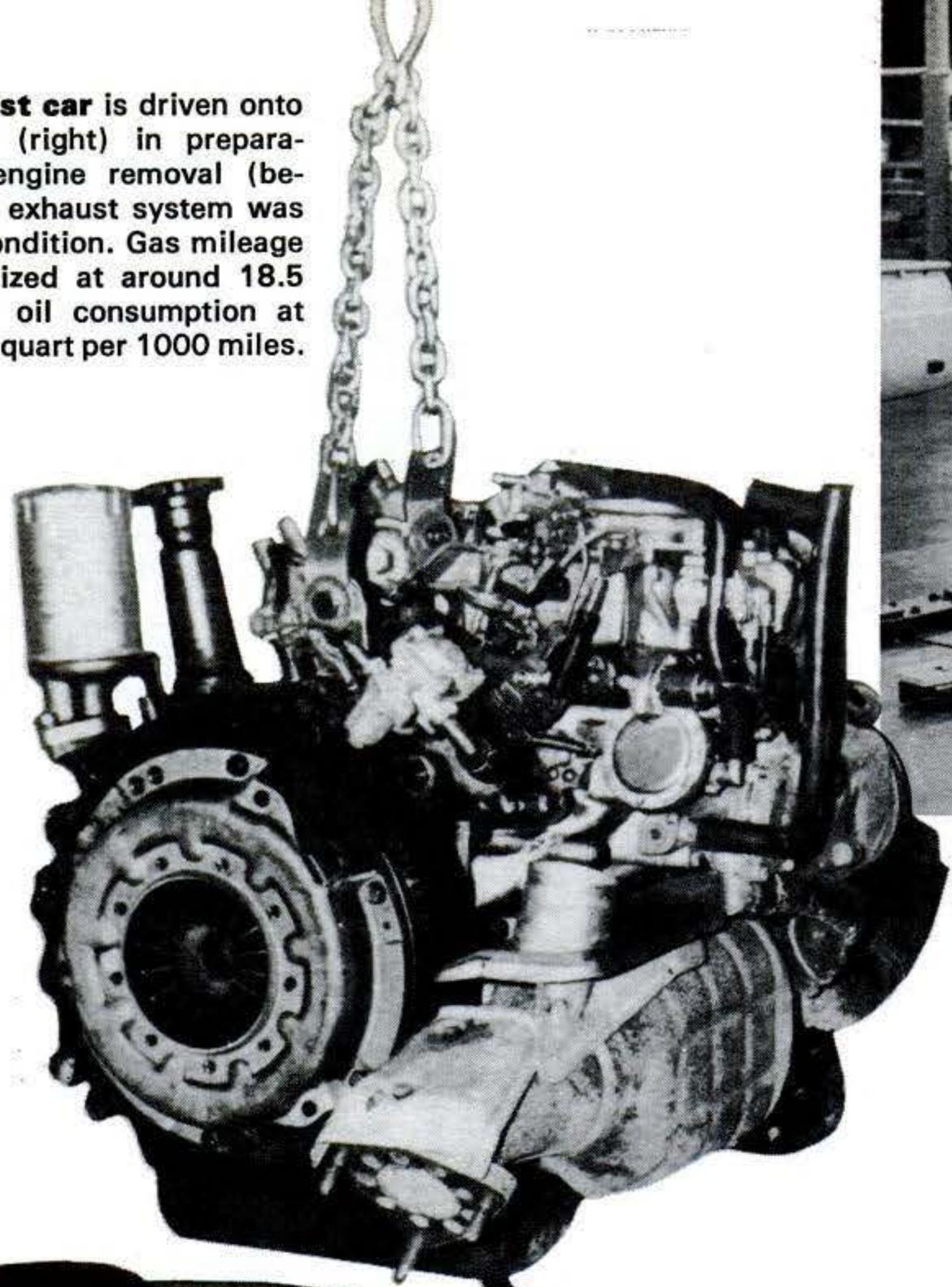
The Pyro-5 isn't going to replace the big boys, but the 5000-plus degrees it turns out can do a big job—repairing garden equipment, welding up the kind of bar stock you can buy in a hardware store. It's good for doing metal sculptures, too. In fact, the company offers an assortment of precut metal kits you can weld or braze together.

The big stress is on simplicity. Oxygen flow is controlled by the system. You control the propane, so a single valve does the trick. One limitation is the six minutes it takes an oxygen stick to exhaust. Still, if you need more welding time, slip two sticks in the canister, lighting only the bottom one.

Find a job needed less than a full burn? Drop the stick from the canister and cut off the burning end. But be careful—both canister and stick are hot.

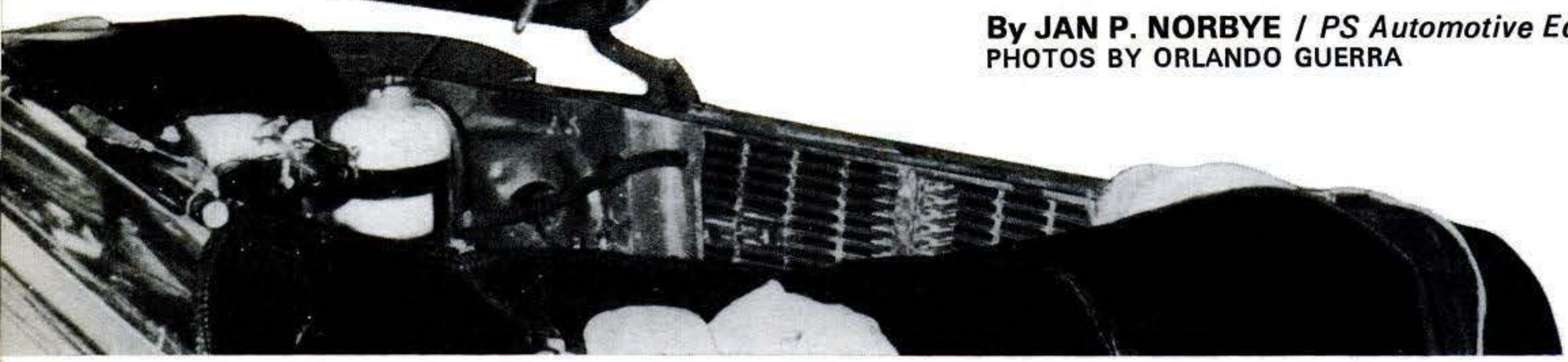
If you can't find the Pyro-5 locally, write Pyronetics, 10025 Shoemaker Ave., Santa Fe Springs, Calif. 90670. The kit is $39.95; extra sticks cost you about seven cents a minute. They come packed in a sealed can for $2.99.*–R. J. De Cristoforo*

Mazda test car is driven onto the hoist (right) in preparation for engine removal (below). The exhaust system was in good condition. Gas mileage had stabilized at around 18.5 mpg, and oil consumption at about one quart per 1000 miles.



MAZDA RX2: 18 Months

By JAN P. NORBYE / *PS Automotive Editor*
PHOTOS BY ORLANDO GUERRA



The car was running beautifully, and it seemed a pity to tear down the engine, but we had reached our target mileage—30,000 miles—and it was time for a durability report.

Is 30,000 miles a true test of durability? In this case, it is, because the miles were put on in the space of 18 months by at least 12 different drivers, under every imaginable set of driving conditions, including much abuse and neglect. We feel that these 30,000 miles are more representative of actual consumer use than 60,000 miles would have been if racked up in short order, under favorable conditions.

For our first check we wanted to know if there had been any deterioration in emission control. We bought the car in California in August, 1971, and it had met local (California test cycle) standards by a wide margin when new:

	1971 Calif. standard	New Mazda RX2
CO	23.0	8.75 g/mile
HC	2.2	1.67 g/mile
NOx	4.0	1.4 g/mile

After 30,000 miles, the City of New York's Department of Air Resources ran a test under the 1972 federal procedure, with the following results:

	1973 Federal standard	Mazda At 30,000
CO	39.0	25.49 g/mile
HC	3.4	7.3 g/mile
NOx	3.0	1.35 g/mile

The rise in HC and CO emissions was judged to be due more to the difference in test methods than actual deterioration. The federal test includes a tough cold-start requirement.

How would the Mazda compare with '71-model piston-powered cars? "Cleaner than average," members of the N.Y. test crew told us.

In its first 30,000 miles, the basic engine never gave a moment's trouble. Some minor problems: At about 20,000 miles it stalled—would not idle. We replaced the coasting valve in the emission-control system, and that did the trick. We had difficulty keeping the front wheels aligned, and the clutch failed shortly before 30,000 miles. But the power unit rates 100 percent on reliability.

Seal-tip wear. The only severe wear point in the Wankel is the interface between the seal tips and the trochoidal track. The track is hard chrome, the seals carbon-impregnated aluminum (soft).

A new seal is 10mm high. Here are our measurements: 9.68, 9.61, 9.49, 9.61, 9.76 and 9.77mm. Mazda recommends seal replacement when they're worn down to 8mm (but it's not really necessary until between 7 and 6mm).

How much life was left in our seals? Take the one with the most wear—0.51mm in 30,000 miles—and project. At a constant wear rate, that would mean 90,000 additional miles. Of course, you can expect increased wear as the track begins to deteriorate, but another 60-70,000 miles seems a safe estimate, for a total of close to 100,000 miles, before a seal change is even recommended. And you can count another 50-60,000 miles (or a total of at least 150,000) before new seals are *really* needed.

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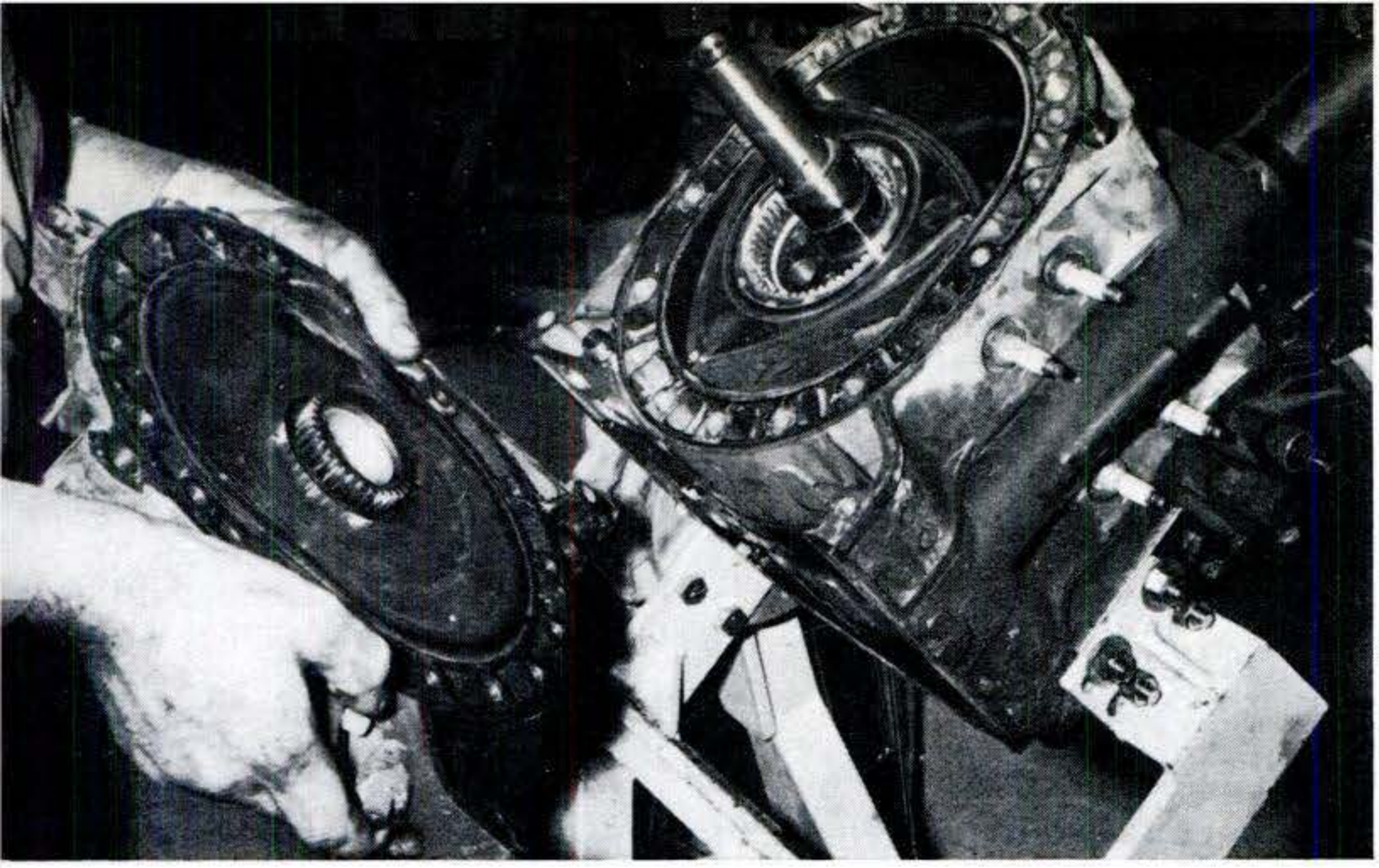


First look inside (left) as mechanic Mike Gorman removes the front cover, laying bare the front rotor: Everything appeared normal. With the rotor pulled out and shed of its seal strips (above, right), it shows brown deposits in the combustion recess, giving evidence of full burning and efficient running. The clean rotor next to it is brand-new and shown for comparison only.

Engine teardown and examination show minimal wear. Seals? Good for at least another 100,000 miles

and 30,000 Miles on a Wankel

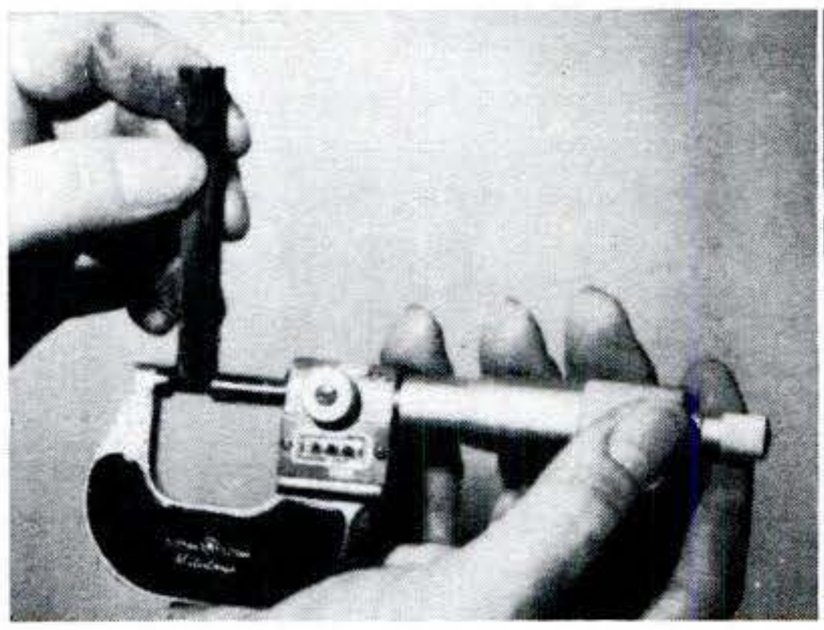
Other wear points. The side seals (gas seals near rotor edge) are 3.5mm high when new. We measured a few, and found most worn to 3.47-mm. That's a negligible wear rate. The oil seals (around the rotor ring gear) had used up about 25 percent of their expected life, which means they would be good until 120,000 miles. Maximum wear on the end covers and center separating walls tends to center along the minor axis. We found a wear range from 0.02mm to 0.05mm: of no significance.

Wear on the trochoidal track was too small to measure. What about heat distortion? We found no shrinkage in the hot zone (from the spark plugs on down), and no deformation of any kind in the aluminum castings. Looking at the track, we found a slight discoloration down from the leading spark-plug hole—probably due to fuel characteristics (or additives). We also found superficial scratch marks up from the exhaust ports. This is the zone where the seals have no lubrication, since the oil fed in with the charge has been burned and swept out the exhaust port. An observation—not a danger point.

Gears were like new. Nice and shiny, with no wear marks. That's impressive, for high rpm's tend to cause wear on the rotor ring gears and the stationary reaction gears, and our Mazda had had more than its share of high-rpm driving.

Finally, we examined the thermal reactor, which is attached immediately beyond the exhaust ports. It burns leftover hydrocarbons with the aid of supplementary air injection, which helps reduce both HC and CO emissions. The reactor's detachable ports were removed, and showed a thin, even layer of brown-colored deposits—signs of ideal functioning.

The engine was reassembled with new gaskets, etc. We paid $2,706.95 18 months ago, and sold it for an even $2,500. PS

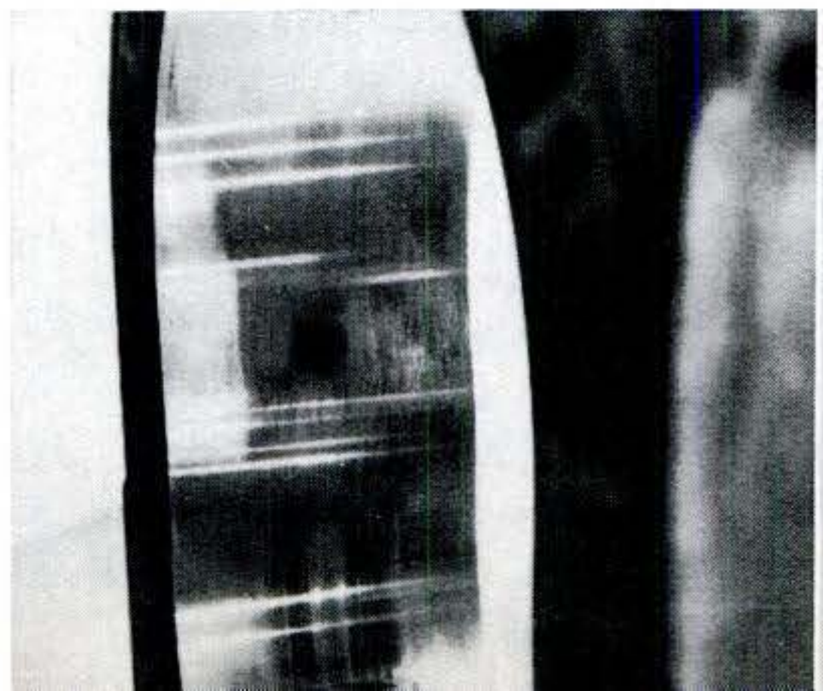


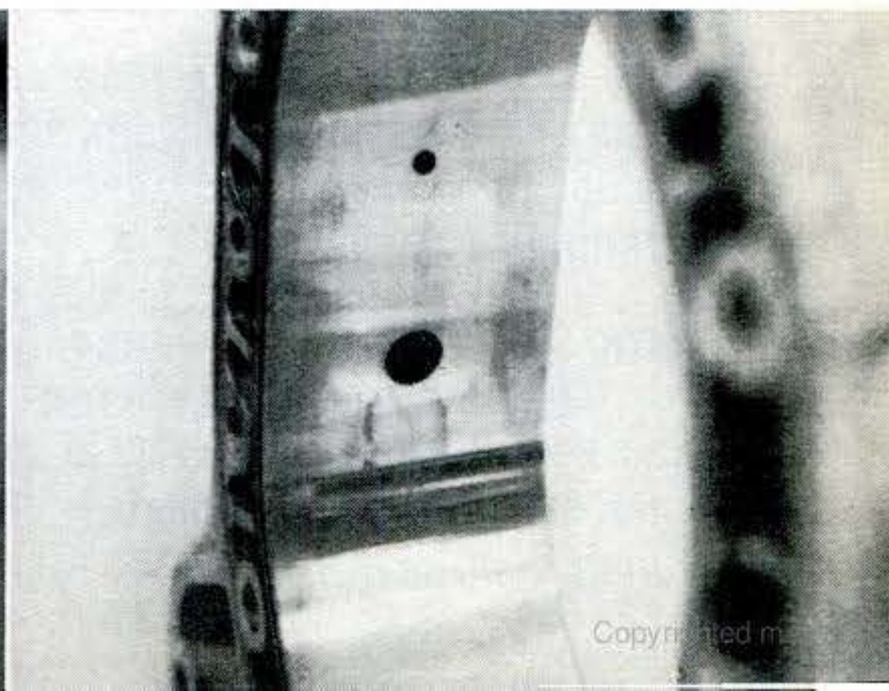
Apex seal wear is measured on micrometer. See text for exact figures. Same seals went back into the engine.

Center separating wall (and end covers) were checked for wear ridges caused by side seals. Verdict: minimal wear.

Chrome-plated track was polished to better-than-new finish. Scratch marks above exhaust port were superficial.

Slight discoloring appears below leading plug hole (wide dark band is only a light reflection on the track).





Outboards, chain saws, snowmobiles...

The Right Oil for Your Two-Cycle

Here's how to get the best service from two-strokers and stop costly repair bills

By E. F. LINDSLEY
PS Midwest Editor

If you own even one two-stroke engine you've got a lubrication problem. If you own one or more outboards, a chain saw, a brush cutter, a snowmobile, a two-stroke power mower, a trail bike, or other such gear, you've got an equal number of lube problems.

Right off, let's admit that the engine makers would prefer you use the specific oil they market under their brand names. Your engine was developed and tested with that oil, and the makers all emphasize that they're anxious (naturally) to see you happy with their engine.

We queried both outboard makers and chain-saw firms, and they pretty much agreed. For best performance and engine life:

- Use the manufacturer's private-label oil.
- Mix to the exact proportions given in your owner's guide.
- Mix oil and gas thoroughly; this is extremely important.
- Use only fresh, clean gasoline. Regular grade is always okay; lead-free and low-lead are less favored.
- In lieu of brand-name oil, use one that meets BIA specification TC-W.

Car vs. two-stroke. Why is it that you can run your car on almost any high quality standard-brand motor oil without problem, but two-stroke-engine builders feel they must offer their own brands? Your outboard or chain saw carries oil through almost instantly, and unlike car oil it's never reused. Automobile oil, therefore, must be doped with additives to resist: oxidation; crankcase pollution from water, fuel, and combustion products; foaming; and deterioration that occurs from time and temperature.

Your car's oil must also disperse and hold suspended fine contaminants that would otherwise plug and coat working parts. But none of these additives is needed in exactly the same way in a two-stroke. Some can even be very harmful.

To compound the problem, two-strokes may be either water-cooled (most large outboards) or air-cooled (small outboards, chain saws, etc.). Thus, combustion-chamber temperatures vary in heat and demands on oil. Moreover, two-stroke engines have many different cylinder-bore materials, finishes, ring setups, and running-clearance variations.

Unfortunately, even if you know all this, it doesn't help much if you find yourself in a situation where you can't run to the dealer for a can of brand-name oil.

Labeling standards? We scouted local filling stations, shopping centers, hardware dealers, and others selling oil for outdoor power equipment. Within an hour we had a bushel basket of cans variously labeled: Two-Cycle Oil, Small Engine Oil, Outboard Oil, and so on. A few carried the label, "For Service TC-W," and a few claimed to meet "BIA Standards," or words to that effect.

The BIA (Boating Industry Association) has arrived at a performance standard and a TC-W (two-cycle, water-cooled) test procedure for evaluating oil performance through hard work and cooperation with engine makers. Oil certified under BIA's test procedure is an excellent outboard oil, and chain-saw engineers say it is an acceptable second choice (to their firm's brand) for their air-cooled engines.

Meanwhile, another task force has been at work on a TC-A (two-cycle, air-cooled) test procedure. This is a bit tougher. The little air-cooled engines tend to be more varied in design and requirements. No TC-A oil or test procedure is yet available, but it's probably coming.

Right now, however, there are probably close to 50 lubes listed by BIA as meeting BIA specs. Many are sold under engine-makers' brand names. Although there is no single, universal oil that meets all outboard and chain-saw needs to everyone's satisfaction, TC-W oil, for the present, comes closest.

The worst engine damage, engineers stress, is caused by owners who are careless in mixing—either in proportions or failing to agitate the mix sufficiently.

New mix ratios. Most manufacturers say you can use modern oils with lower proportions of oil to gas, even with chain saws and outboards

TWO-CYCLE VS. FOUR-CYCLE OIL REQUIREMENTS

	Two-Cycle	Four-Cycle
LUBRICATING CHARACTERISTICS	VERY IMPORTANT	VERY IMPORTANT
CHEMICAL STABILITY	UNIMPORTANT	VERY IMPORTANT
SLUDGE-HOLDING ABILITY	UNIMPORTANT	VERY IMPORTANT
PUMPABILITY AT LOW TEMPERATURE	UNIMPORTANT	VERY IMPORTANT
RESISTANCE TO HIGH-TEMPERATURE THINNING	IMPORTANT	VERY IMPORTANT
SOLUBILITY IN GASOLINE (MISCIBILITY)	VERY IMPORTANT	UNIMPORTANT
CORROSION PREVENTION	IMPORTANT	DESIRABLE (VERY IMPORTANT FOR COLD WEATHER, SHORT-TRIP SERVICE)
RATIO OF FUEL TO OIL BURNED	15:1 TO 60:1	TYPICALLY 300:1
TENDENCY TO FORM CHAMBER DEPOSITS	VERY IMPORTANT	UNIMPORTANT
ASHLESS INSTEAD OF METALLIC DETERGENTS	VERY IMPORTANT	UNIMPORTANT
RING STICKING TENDENCIES	VERY IMPORTANT	IMPORTANT

Differing demands of two- and four-cycle engines in McCulloch Corp. table result from oil reuse in four-cycles.

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Engines

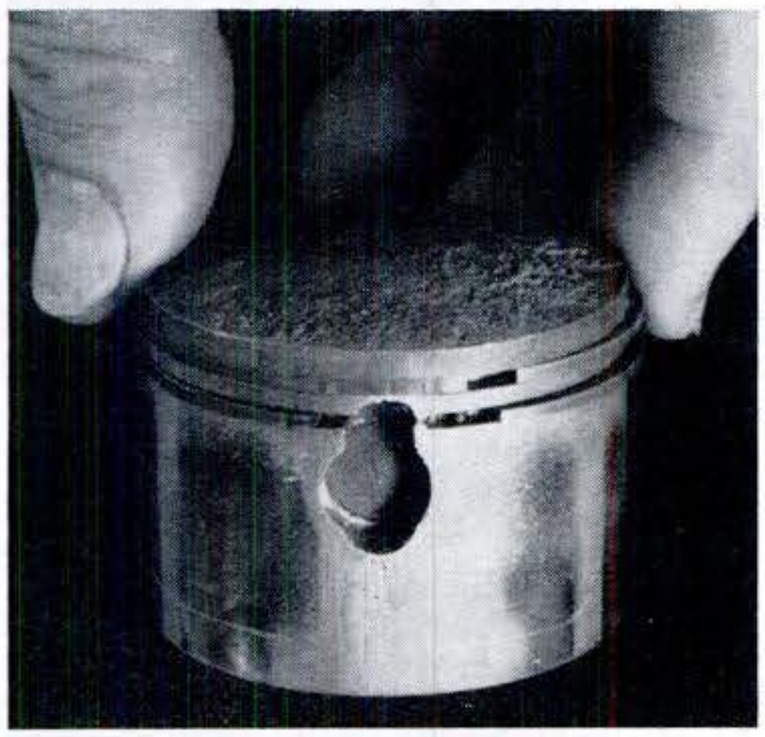
Best oil for your two-strokers is engine-maker's brand. With a variety of engines, you may acquire a collection of oils. Make sure you use correct oil-gas mix ratio.

Read the label when you can't obtain engine-maker's brand. Two above are for Service TC-W (two-cycle, water-cooled).

built years ago that call for higher amounts of oil. One saw maker, Pioneer, prefers to have you stick with the original mix. If in doubt, use the old mix as specified.

Summed up, if you use the maker's oil and have a variety of equipment with different mix ratios, you'll wind up with a number of containers, each for a different engine. This is safer than trying to use one mix in everything, but can still be dangerous unless you label containers clearly.

While all these recommendations are aimed at getting the best from your engine, there are times when you just can't lay your hands on the maker's oil or TC-W oil. What then? Most chain-saw engineers advise an oil marked "For Two-Cycle Engines" by a *major* oil refiner. Such oils should be fine for occasional or emergency use.



Ruined chain-saw piston could be result of wrong oil, wrong mix, or over-lean setting of the carburetor.

Surprisingly, we were told that too much oil, from careless mixing, can be very harmful. Excess oil apparently raises combustion temperature and gives you a hot-performing saw, but only briefly and until something lets go.

What about proprietary additives, engine improvers, and other "miracles-in-the-can"? All engine builders gave an absolute "No!" to these products. The only ones they suggested were gasoline stabilizers, such as OMC's fuel conditioner to prevent storage gumming, and fuel antifreezes for extreme cold weather.

Special detergents. For one thing, the maker's oils are already heavily compounded with chemicals carefully suited to two-stroke use. Detergents, for example, are essential for engine cleanliness, but they must be the right detergents. Here's how one major chain-saw firm sums up what may occur without these specialized detergents:

- Varnish decreases cylinder clearances, which can cause piston scuff and sticking.
- Deposits stick rings, permit blow-by, lower compression, and overheat pistons.
- Exhaust deposits lower power and can start fires when incandescent.
- Combustion-chamber deposits promote detonation, may batter ring lands closed.
- Deposits foul plugs, cause bad performance.

Obviously, it's foolish to take chances with additives that may not be compatible with the maker's oil.

Leaded gas? Lead-free and low-lead fuels are not quite so roundly damned by two-stroke builders as they were a year or two back. Some say the lead-free fuels are now much better than the originals.

As near as we can pin down, lead-free and low-lead fuels are all right for smaller engines, but regular gas is still the preferred fuel. With some larger outboards, lead is still important as a lubricant factor.

So—if you have a two-stroke lube problem:

- Use either the maker's brand oil or TC-W.
- Mix to exact proportions.
- Mix thoroughly.
- In a pinch, use SAE 30 non-detergent oil.

Avoid automobile oil, multigrades, old gasoline, trick additives, unknown premixes, and over-lean carburetor settings. PS

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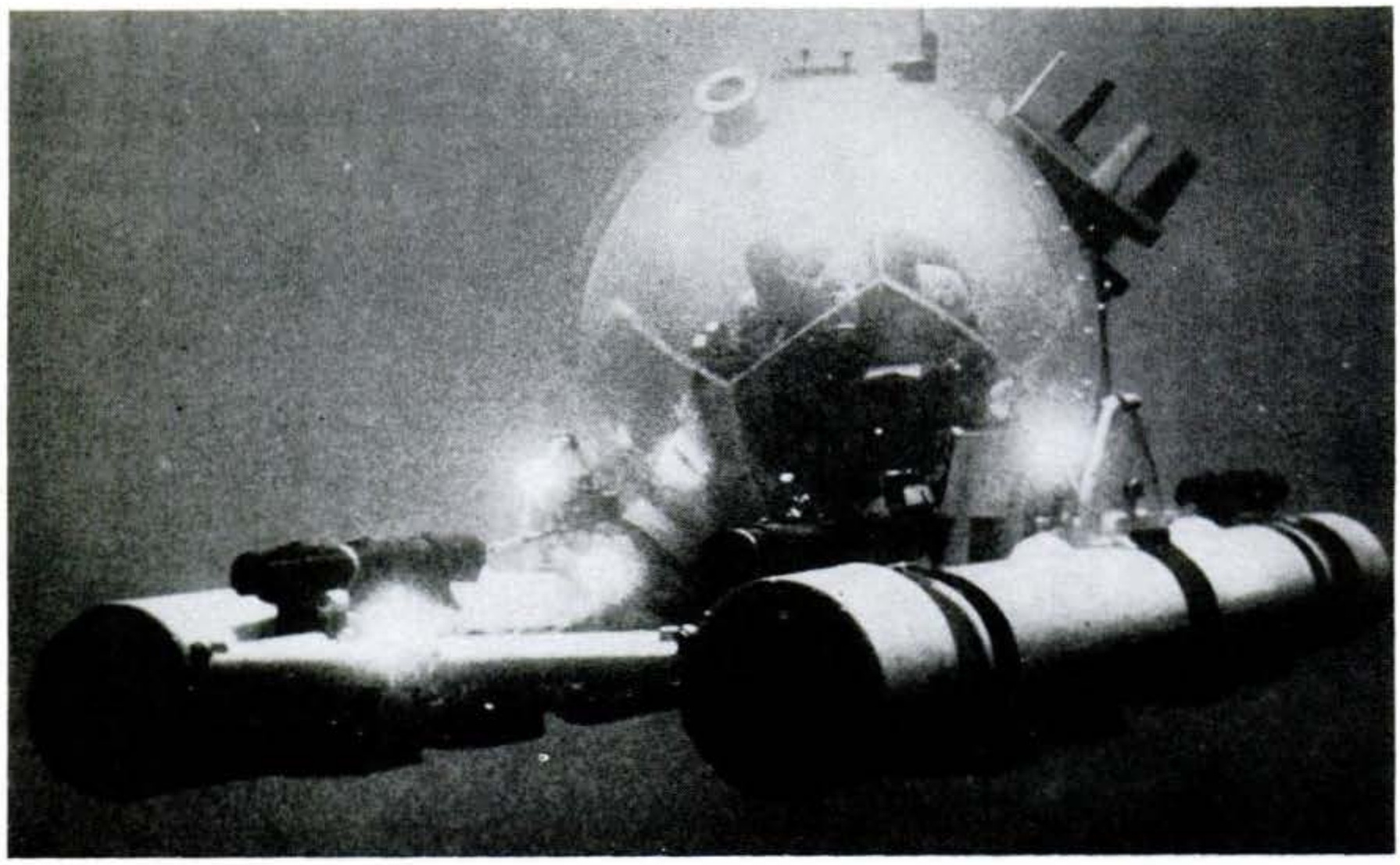
What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS

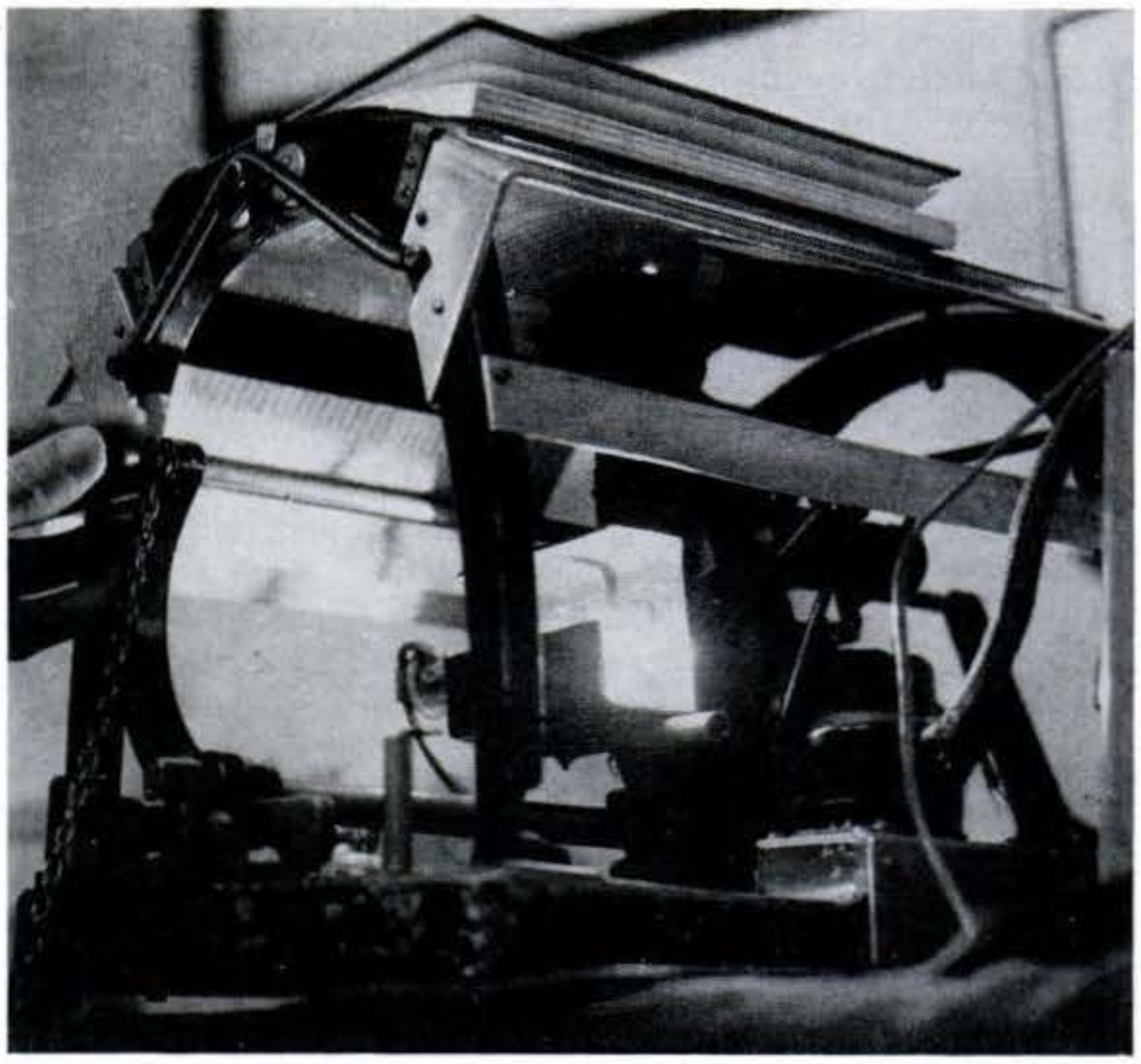


"Helicopter" sub gives crew panoramic view

Looking like a copter without blades, this Navy submersible is being tested off Hawaii to see whether more should be built. The vessel's 2½-inch-thick, 66-inch acrylic dome enables scientists to study ocean life and take photos as far down as 600 feet. Lead-acid batteries—powering two cycloidal thrusters—are housed in the two pontoons. There's a 12-hour air supply for a crew of two, plus an emergency backup system. Control signals are transmitted through the sphere on a modulated light beam to an outside receiver. This keeps most machinery outside the hull, minimizing heat buildup and providing more inside space.

Bike-motor kit

Here's a two-motor kit that converts any bicycle to battery-powered friction drive. A five-hour, 20-mph capability gives you a 100-mile range. An adapter is included with the battery for overnight recharging. Go-Pak is $99.50. Maker: Ideas Engineering Corp., 6911 Topanga Canyon Blvd., Canoga Park, Calif.



Money machine

Need cash? In England, card holders accredited by Lloyds Bank can draw up to 100 pounds a day from this dispenser. Customers insert their magnetically encoded card and key in a secret identity code. Details are sent by phone line to a central computer, which authorizes payment within 40 seconds.

Musical reader

Put a book on this gadget and the printing is converted into musical notes by photocells. Using experimental versions of the optophone, blind persons in England, and with the V.A. here, can "read" non-braille printing. A six-part light beam scans a line, generating combinations of six notes for each letter.

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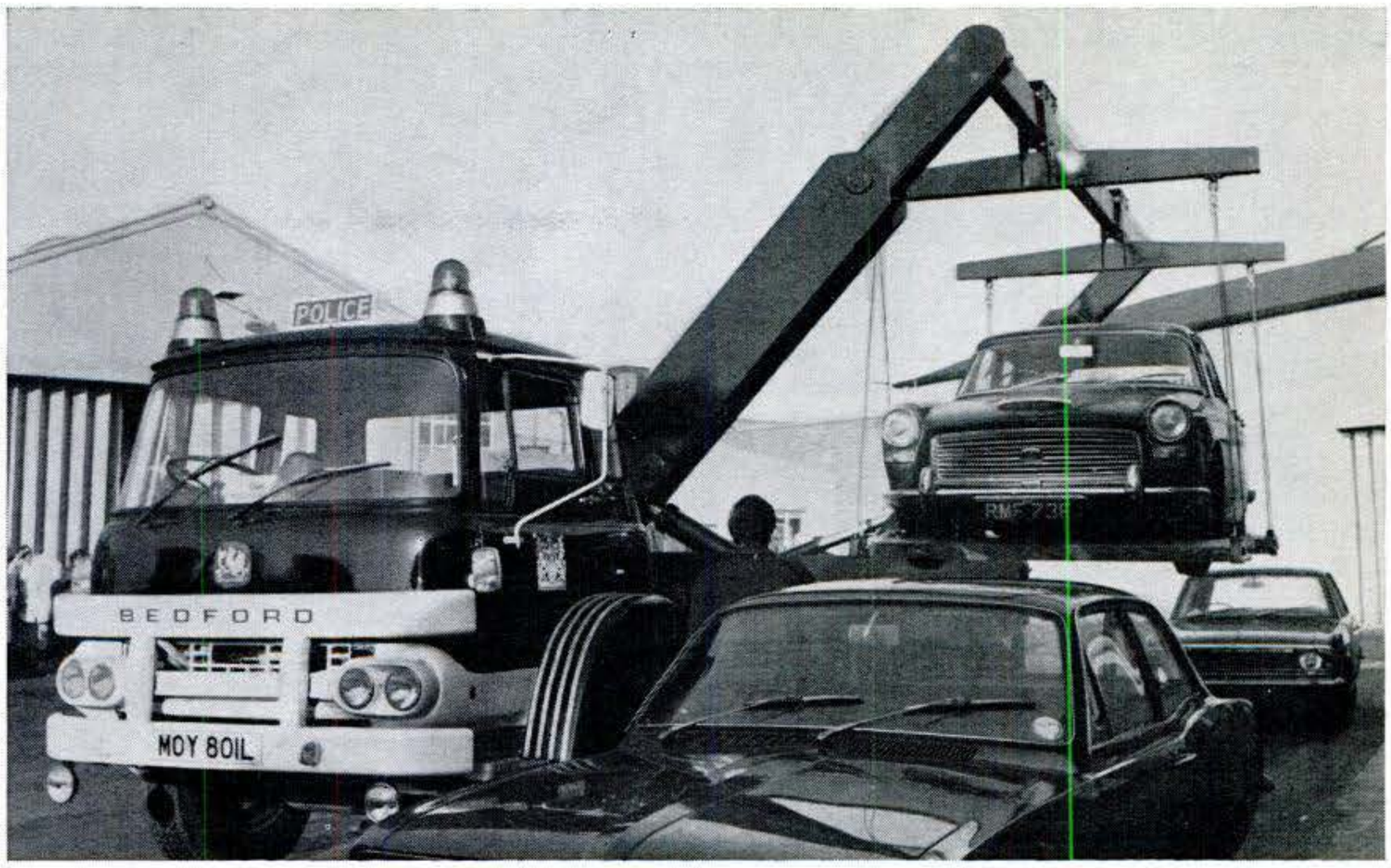
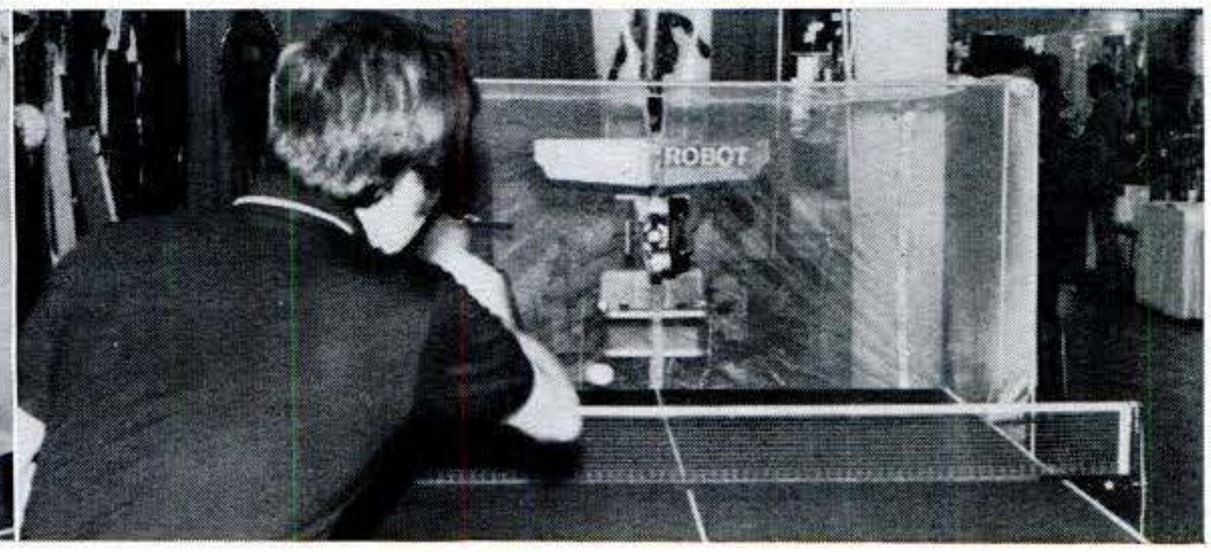
Up and over for misparked cars

London police are using this lift-and-carry truck to move illegally parked cars in a hurry. The rig has a pair of telescopic lifting arms tilted left or right by hydraulic rams. A central beam supports rolling cross-arms that carry slings for the front and rear wheels. For pickup, twin bars on the slings are locked around the wheels, and the offending car is hoisted up and over to the truck bed. The entire operation takes under three minutes, with little inconvenience to passing traffic. The loader can handle a three-ton car up to 21½ feet long.





Ping-pong robot

Sharpen up your table tennis? You can, with the Stiga Robot (left), a Swedish-made serving machine. From 30 to 80 balls per minute come at you—with preset top, back, and side spins or looping. Controls are under the hopper (far left). General Sportcraft Co., Bergenfield, N.J. 07621.

Tire-profile gauge

Now you can measure a tire's sidewall shape to regulate air pressure for the actual wheel load. This puts full tread width on the road for the best traction and braking, minimizing wear. A needle indicates over-, under-, or proper inflation for a given load. M. Thaler, Innstrasse 26, 6020 Innsbruck, Austria.

Bowling scorer

Just dial your pinfalls into AMF's EasyScore, push a button, and your cumulative score appears on the scoreboard. Scores are calculated electronically. Want a record? Push another button for a printout. For league play, the scoring machine calculates handicaps for bowlers and teams.

Air support

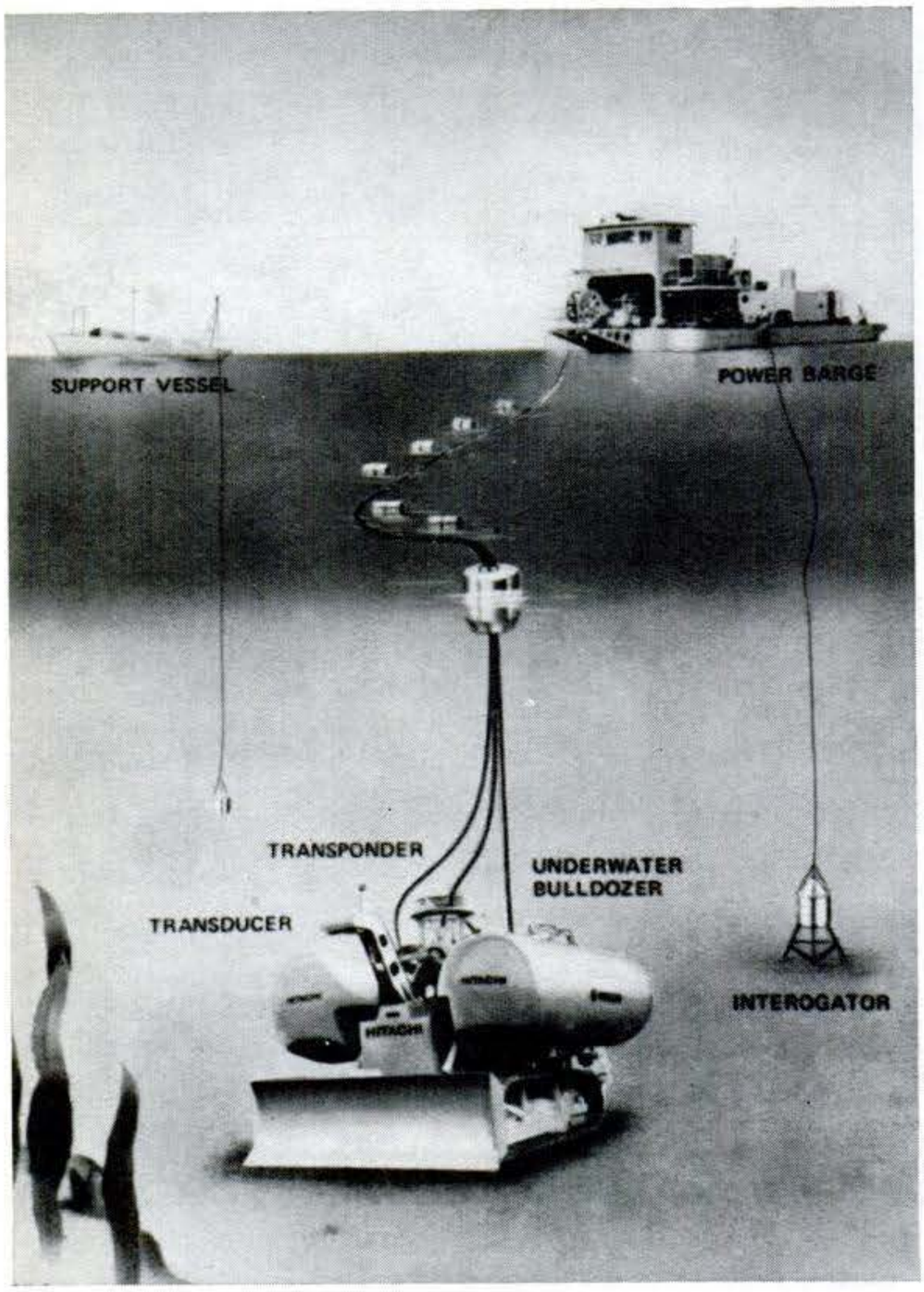
Air Hockey's the name given by Brunswick Corp. to this game. A plastic puck, riding on jets of air from thousands of holes in the table, skates and ricochets wildly around, as you and your opponent vie to smack it in each other's slots. Commercial version is coin-operated, but a smaller, home version is on the way.

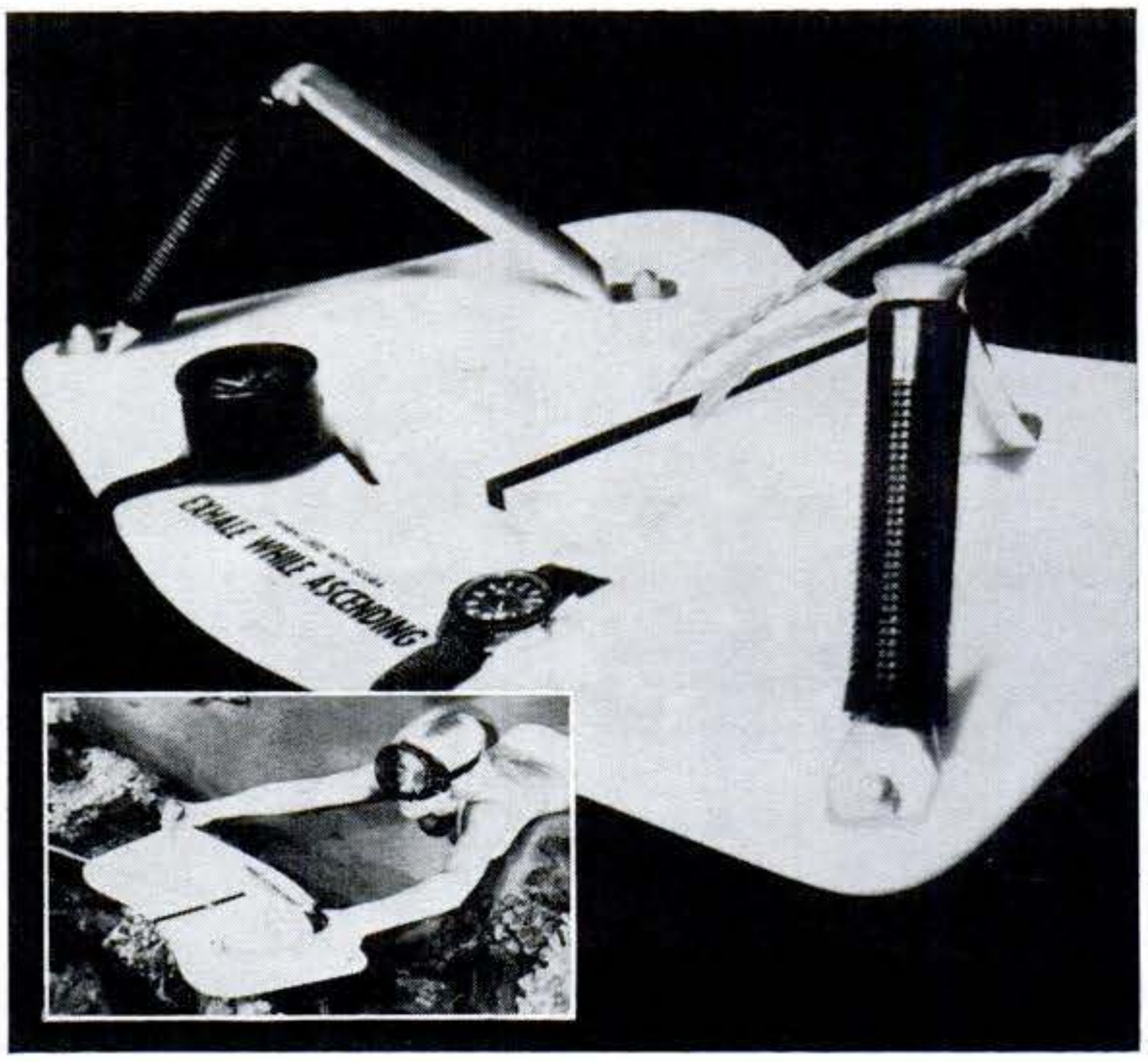
Copyright material

What's New

Bike trunk

It's built for baggage, but here Junior demonstrates Trip Trunk's giant 5½-cubic-foot capacity. Width is 30 inches, and it adds 38 pounds to your motorcycle by replacing the fender. About $300 for Honda CB 750 and 500s only. Brockway Honda Sales, R.D. 2, Brockway, Pa. 15824.





Sonar-eye bulldozer

Japanese-built, this remote-control bulldozer system can operate in 200 feet of muddy water. Sonar pulses from the interrogator activate the machine's sonar transponder, telling the barge crew where the bulldozer is. A front-arm sonic transducer maps the sea bottom in front of the blade.

Diving saucer

Enjoy underwater sightseeing? Hang on, take a deep breath, and steer Underwater Saucer while you're towed 3-7 mph. You control ascent and descent speed by changing the plane angle. Mounting slots for your instruments are built in. $12.95. Michigan Water Specialties, Box 397, Union Lake, Mich. 48085.

Bald-tire warning

You'll know when your tires are nearly bald, with Dunlop's built-in brands. The words "Stop" are formed by inserts attached to the outer mold during manufacture. When the mold is opened, the inserts are withdrawn through the hot rubber. The British firm sees the warning as a contribution to road safety.

Wraparound camper

More stability, easier maneuvering, more space—that's the claim for a new two-wheel camper that wraps snugly over the top of your car. Plastic-paneled British hybrid sleeps four, includes kitchen, shower, toilet, fluorescent lighting. Tubular guides and sockets secure the rear; tensioned rods hook onto the front fenders.

Safety seat

When you buckle up your seat belts for safety, you can also secure the kids with these new carriers. Chrysler-Plymouth dealers now carry this Mopar front-padded child's car seat, plus rear-facing infant carriers. Both use the existing lap-belt systems in the automobile.

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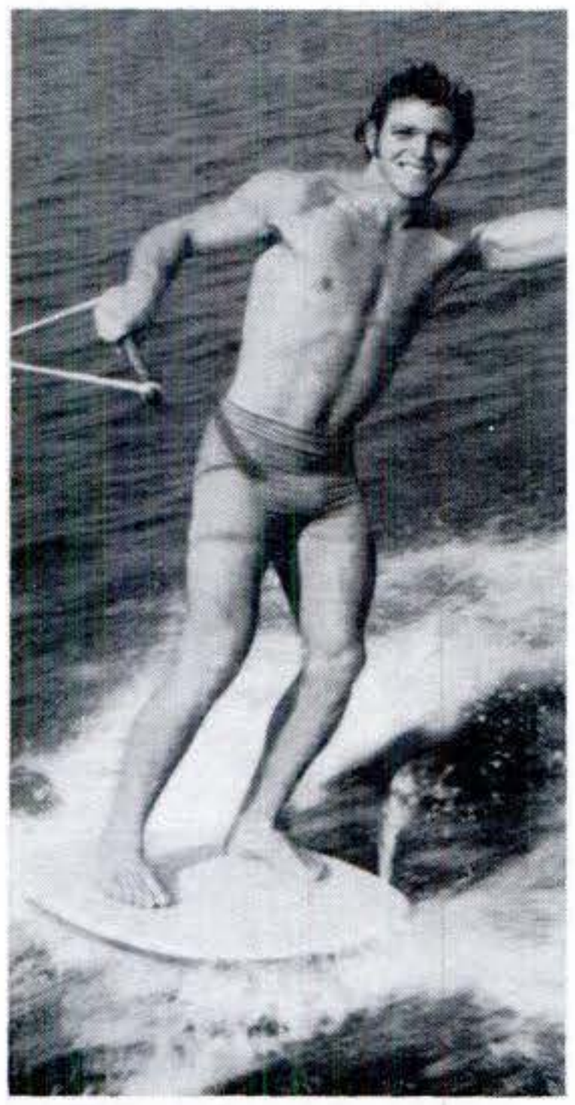
What's New IN OUTDOOR RECREATION

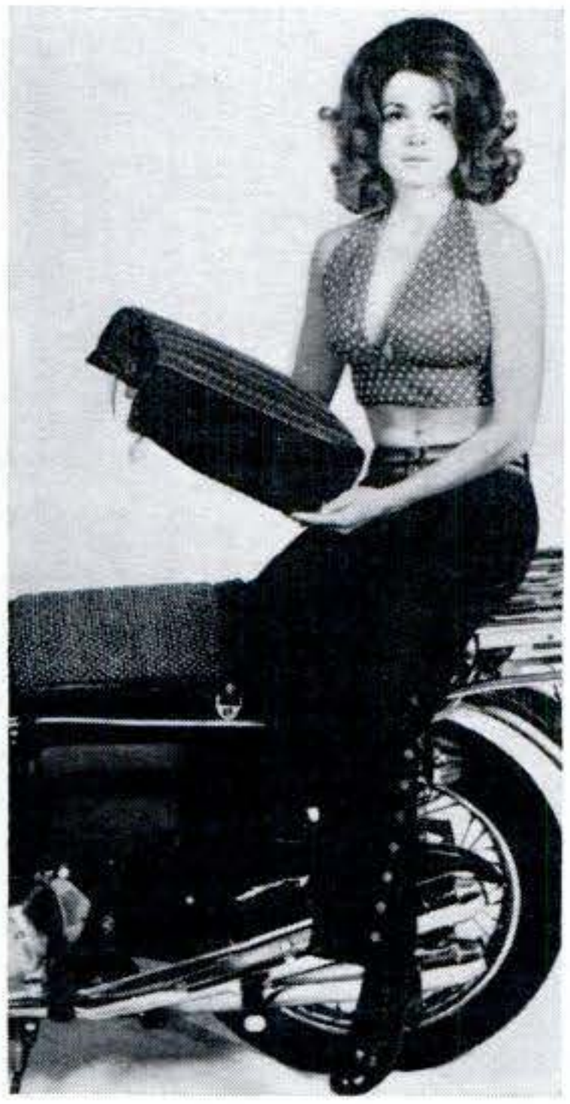
Quick-pitch tent

You can move this nylon mountain tent while it's fully pitched, say the Sears people. It comes in quick-pitch two- and four-man models (5 by 7 feet, 11 pounds; 6½ by 8½ feet, 15 pounds), has a zippered screen and storm doors, and zippered rear window. Prices: $90 and $120, including fly and backpack case.



Floating saucer

A fun machine for the water, the Super Saucer can be towed with a line from rider to boat or from saucer to boat. The S-S is foam-filled for flotation, measures 25 by 32 by 3 inches, and costs about $20, including nine-foot tow rope. It's made by Wooster, Ltd., Wooster, Ohio 44691.



Seat cooler

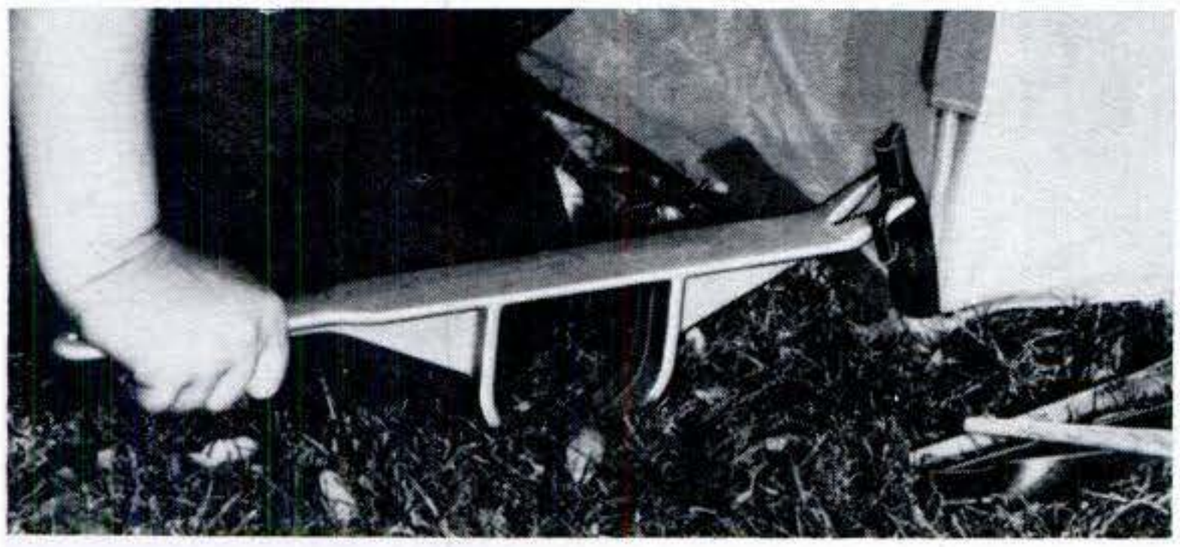
No hot seat in hot-weather motorcycling with this device. It's the Kool Breeze Seat—a wire-and-fabric-mesh cover that fits over your regular seat to admit air. You attach it by clipping two or four springs, depending on bike model. Price: $4.95 from Kool Breeze, 470 Pershing Ave., Mattawan, Mich. 49701.

Portable pot

Only 13 inches high and 13 deep, the Mini-Pot portable flush toilet can be used 25 times before you need to empty it. It holds two quarts of water, plus chemical. It's designed for rec vehicles, boats, and tents, sells for $39.95. Maker: Todd Enterprises, 702 Eddy St., Providence, R.I. 02903.

Shockproofer

Spring-loaded plates covered with resilient plastic cushion the shock of rough seas or wilderness trails for these binoculars—or any delicate instrument, such as a camera, that must be ready for quick use. Glass Pack mounts in cars or boats, costs $8.95 from Wilderness Supply, 2346 No. Bway., Boulder, Colo.



Stake remover

No strain—tent stakes pop out in a jiffy with the new Stake-Out remover, claims the maker (Maier-Hancock Industries, 13212 Raymer Ave., No. Hollywood, Calif. 91605). Just pry and lever. It's made of aluminum, sells for $4.95 ppd.

Take-down bow

A take-down bow with magnesium handle—that's the new Bear '76er Deluxe. It comes in light, medium, heavy, and extra-heavy draw weights; and arrow rest, bowsight, and pistol-handle grip are standard. Maker is Bear Archery, Rural Rte. 1, Grayling, Mich. 49738.

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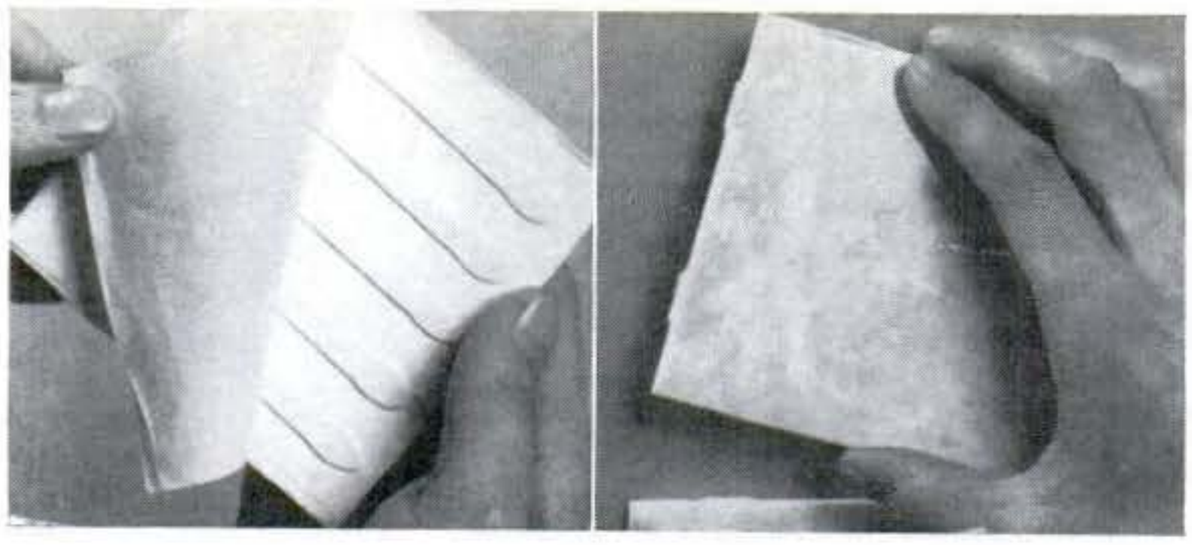
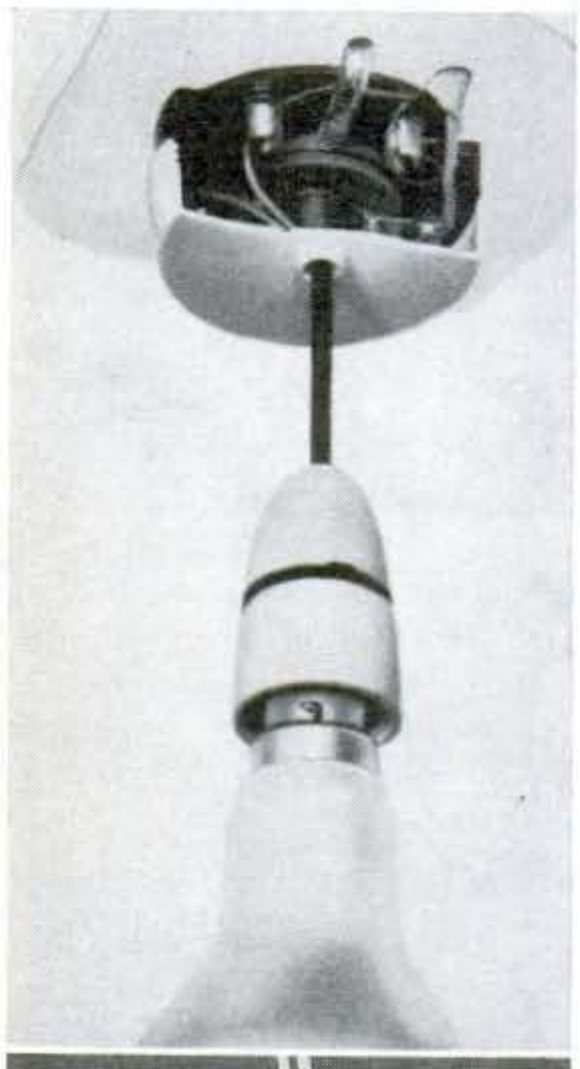
What's New IN HOME IMPROVEMENT



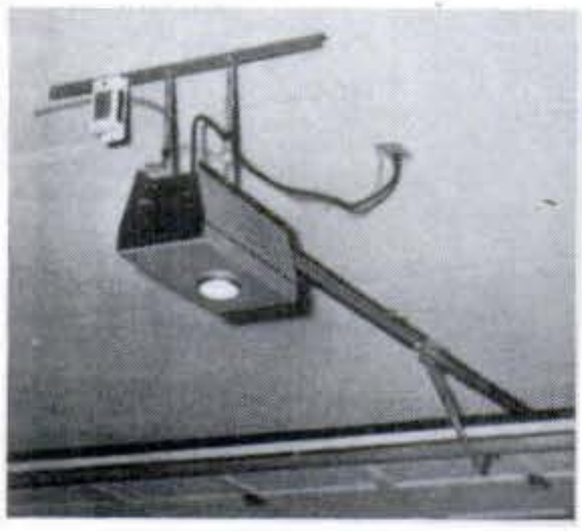
Tacky tiles

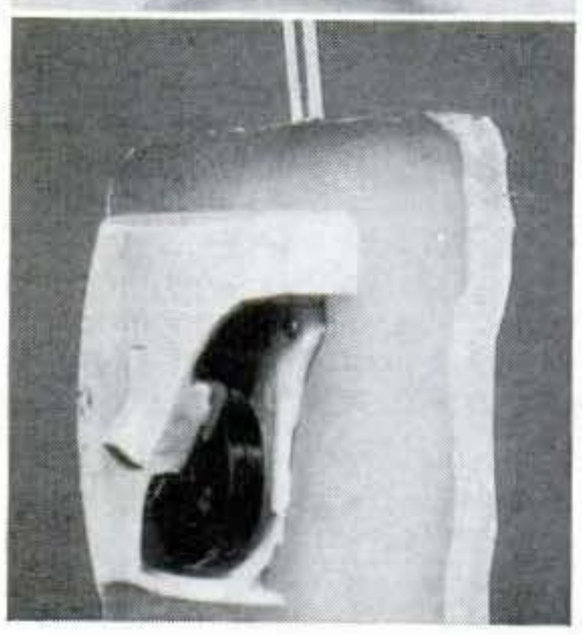
Who needs mastic? These self-adhesive ceramic tiles work like Band-Aids. Pull off the paper backing sheet and stick them in place. (They go on over old tile, too.) Built-in spacers assure alignment so grout lines are uniform. Cristal self-adhesive tiles are made in standard 4¼-inch-square size by H & R Johnson.



Light & sound

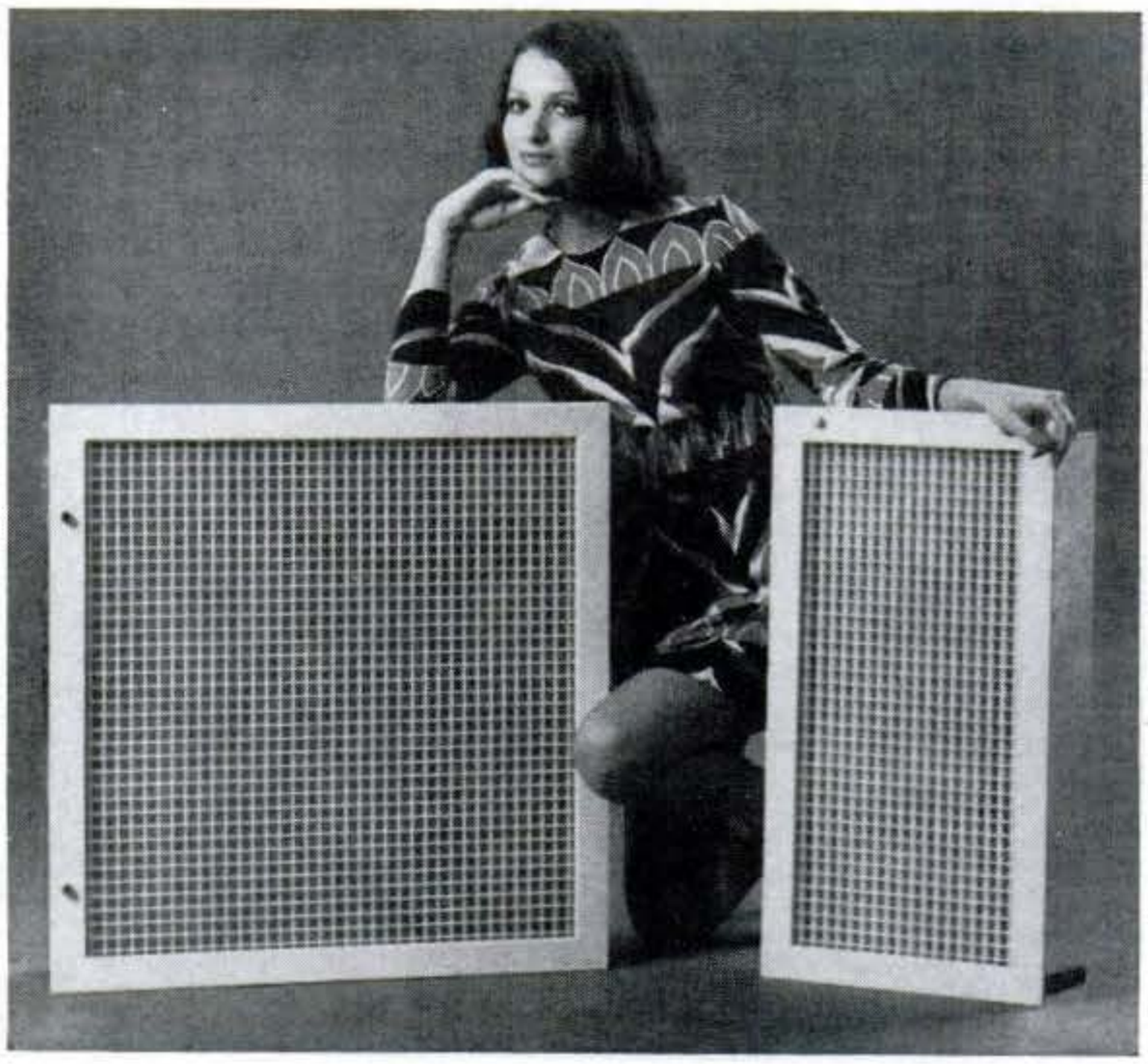
On goes this garage-door light when you press the button of the remote-control hand unit. The secret: sound waves at a special high frequency. The Sonic-Raylight consists of outdoor box and socket, plus hand unit. It's $19.95. Extra outlets are $7.50. Signal Science, 140 Lowland St., Holliston, Mass. 01746.





Air switch

Cheap and easy to install, and 100 percent shockproof, this switch operates by air pulse. Plastic tubing carries the pulse from the switch to diaphragm-operated contacts in a special light socket. Herga Electric, Northern Way, Bury St. Edmunds IP32 6NN, England, makes it.

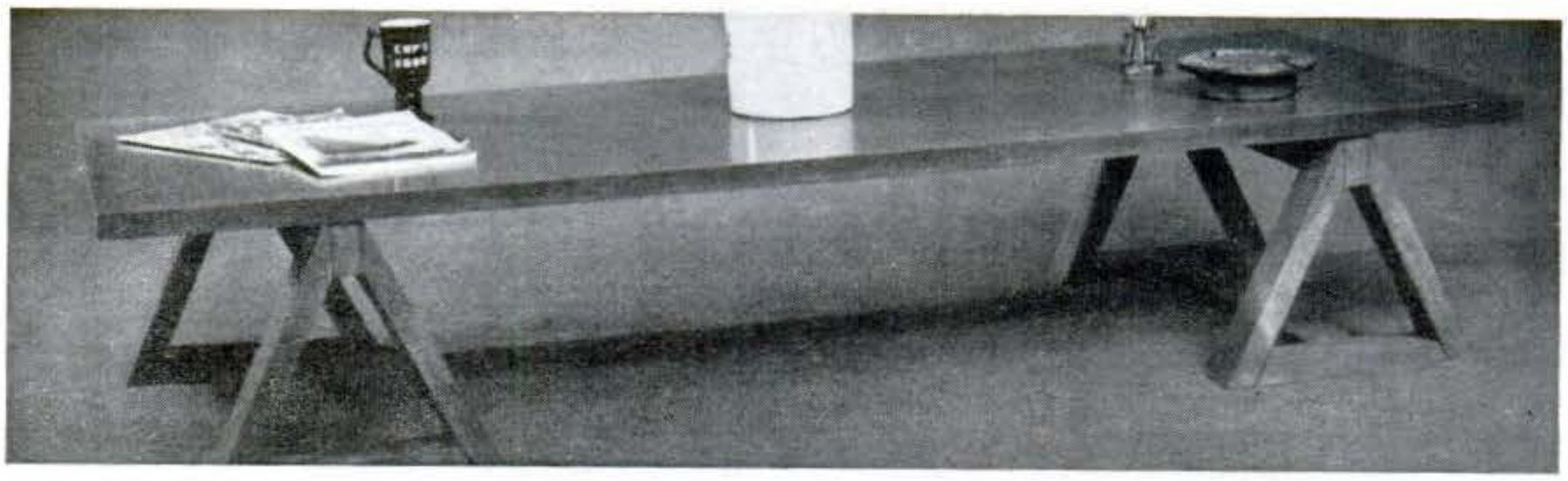


Electric doorman

Convenience and safety are the words for Helpmate's new CD-4 garage-door opener. The R/C opener reverses automatically upon hitting an obstruction. Its built-in lamp turns on when you use the door, turns off about two minutes later. It's $124.95 from Helpmate, 1st and Lake, Baroda, Mich. 49101.

Dust fighter

For central heating or cooling systems without electronic air cleaning, here's a simple add-on: an air-cleaner/grille for the return side of the system. The Honeywell F-52 comes in one- or two-cell units, with easily washable cells. The one-cell unit fits between studs on 16-inch centers.



Basic tables

Utility, simple design, and economy are combined in this kit table, one of three ready-to-assemble models by Peninsula Wood Products (Box 22, Sturgeon Bay, Wisc. 54235). Abbot's table, passage table, and coffee table are offered at prices between $34.50 and $38.50.

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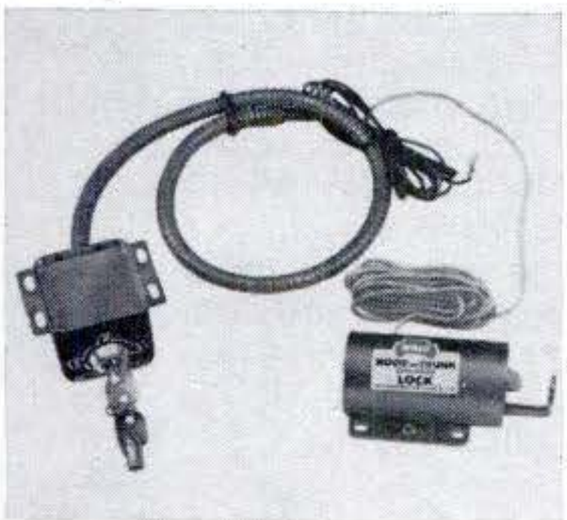
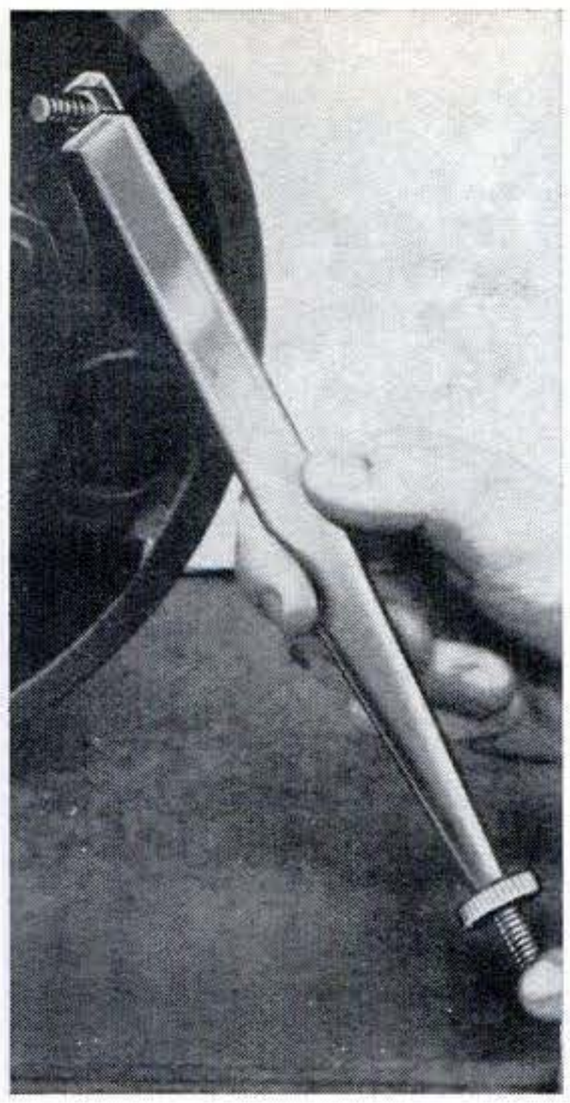
What's New FOR YOUR CAR



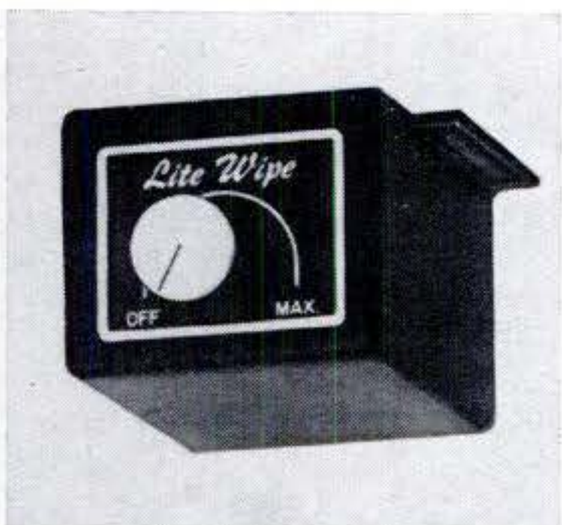
Double lock

Wolo's anti-theft car lock does more than just cut off the ignition; it also locks either your trunk or hood. They can be released only by a control unit under the dash. It's made by Wolo Mfg. Corp., 37 Jefry Lane, Hicksville, N.Y. 11801. Price (in stores): $29.95.



Skinny gripping

Where your fingers can't go, the Handee-Clamp can. Parallel jaws of the long, thin tool open to an inch to grip nuts, bolts and lock washers, hold the choke butterfly open, pinch the vacuum hose closed, and grasp small parts for soldering. It's made by Thexton Mfg. Co., 7019 Oxford St., Minneapolis, Minn. 55426.

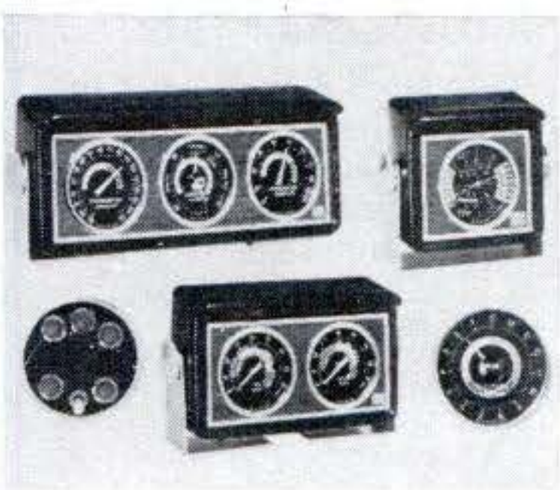


Wiper control

Light mist or splashing water keep you flicking your wipers on and off? Lite-Wipe matches wiper action to rain and road by letting you vary intervals between sweeps from two to 30 seconds. It connects with four wires. $19.95 at stores or from James Electronics, 4050 No. Rockwell St., Chicago, Ill. 60618.

Catchall

Coins, matches, trading stamps, and other small items are within easy reach with the Handi-Sak. You tie the cloth bag to your car's steering column—or you can hang it from the handlebars of a bike. It's $1 from W.V. Krueger, Box 812, San Francisco, Calif. 94101.



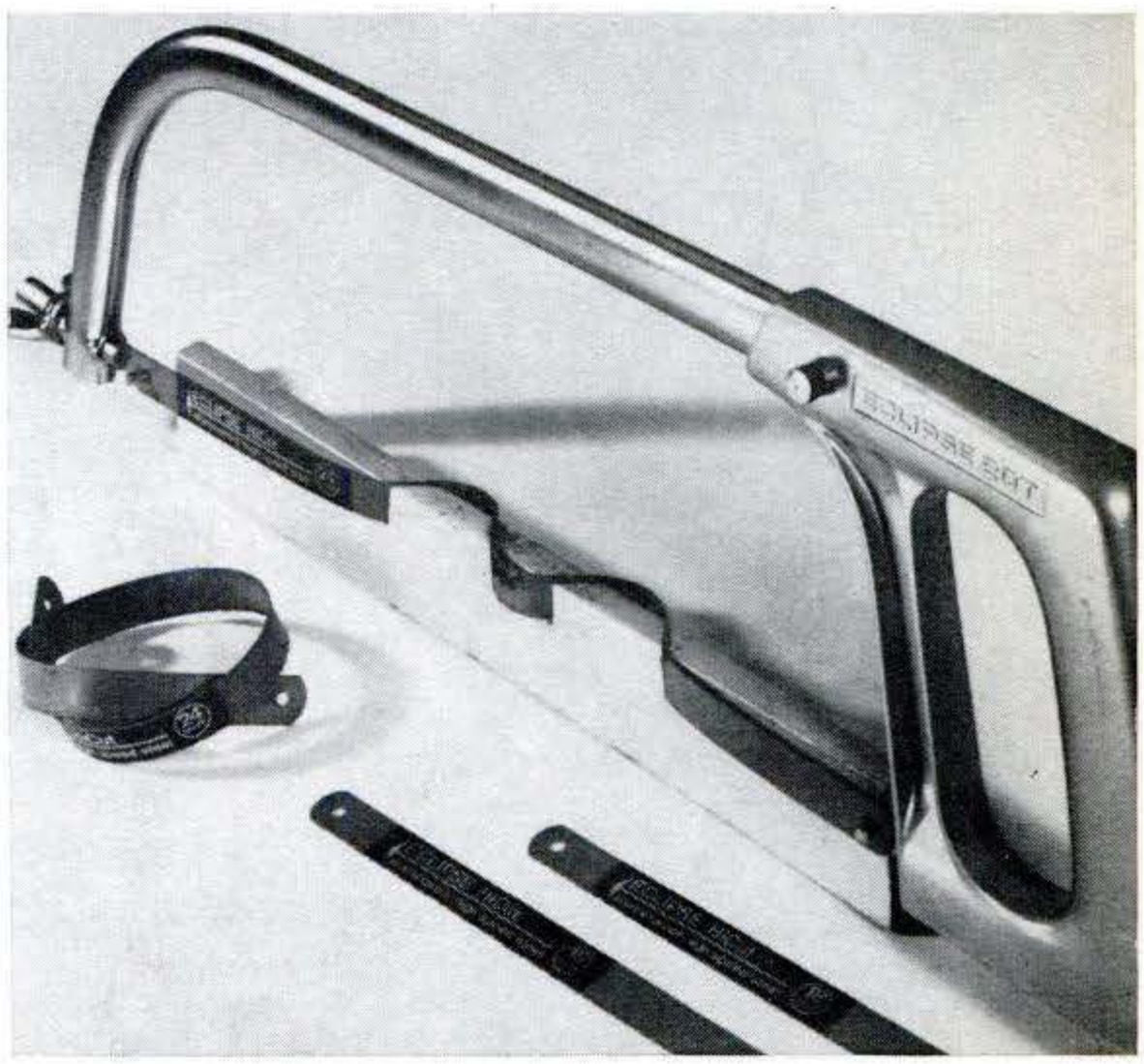
Tell-all gauges

Now there are Mix 'n' Match instruments for your car or rec vehicle. These by Blackstone fit in one-, two-, or three-instrument panels. Instruments include: voltmeter, altimeter, barometer, thermometer, hygrometer, G-force indicator, parking leveler. Blackstone Mfg. Co., 4630 W. Harrison St., Chicago, Ill. 60644.

What's New IN TOOLS

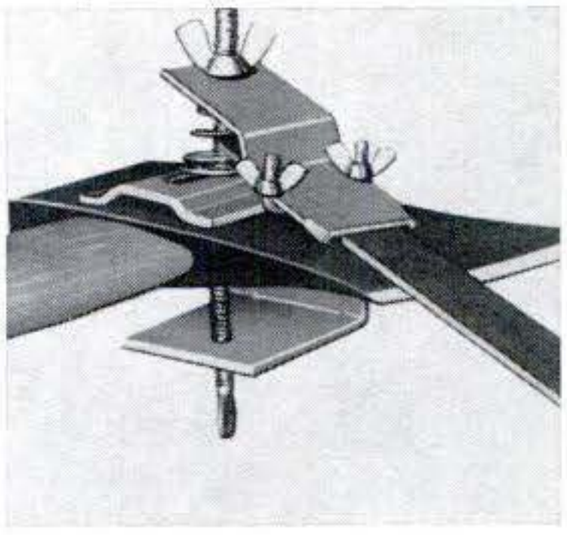
Flex blade

Okay, that hacksaw blade is so flexible you can tie it in a knot, but will it cut? Yes—the secret is bi-metal design. A high-speed-steel cutting edge is electron-beam-welded to a spring-steel backing. It's made in 18- and 24-tooth models. James Neill Ltd., Napier St., Sheffield S11 8HB, England, makes the bi-metal blade.



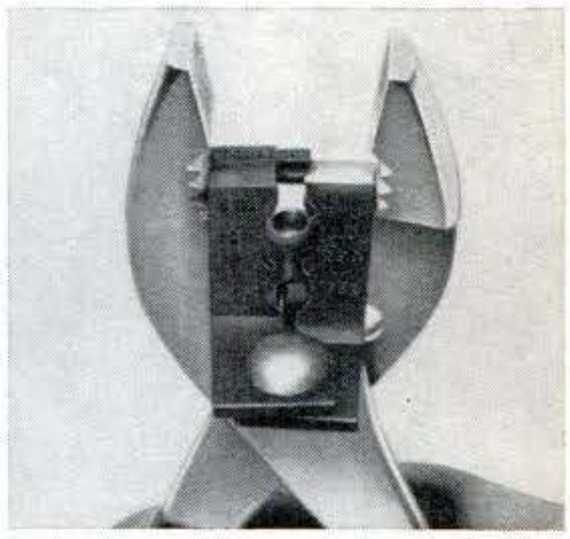
Tangle fighter

Bugged by tangled extension cords? Here's a 20-footer that stores neatly in its own plastic case. Pull out as much as you need—wind it back up when you're done. Hyde-A-Cord is $4.95 from Vangard Products Co., 14547 Titus St., Suite 209, Panorama City, Calif. 91402. It's guaranteed for five years.



Sharp sharpener

A sharp axe with just the right bevel—that's what you get with the O-Max sharpener. It clamps to your axe head and guides a file through smooth, pivoting strokes. Keeps your hands away from the cutting edge for safety. It's $5.95 with file from O-Max, 2317 S. Hampton. Springfield, Mo. 65804.



Crimper conversion

Turn your pliers into a terminal crimping tool? It's easy with the new Vise and Plier Crimping Tool. It fits standard hand pliers, handles all solderless terminals from 22-10 AWG. Wire sizes and directions are marked right on the tool. It's by AMP Special Ind., Box 1776, Paoli, Pa. 19301.

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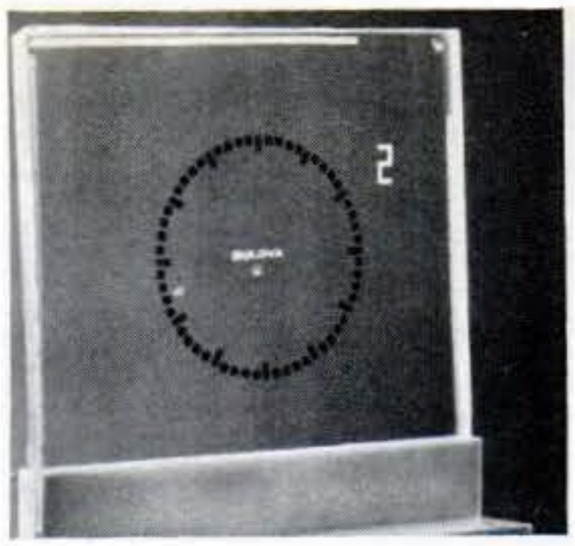
What's New IN ELECTRONICS



Cop caller

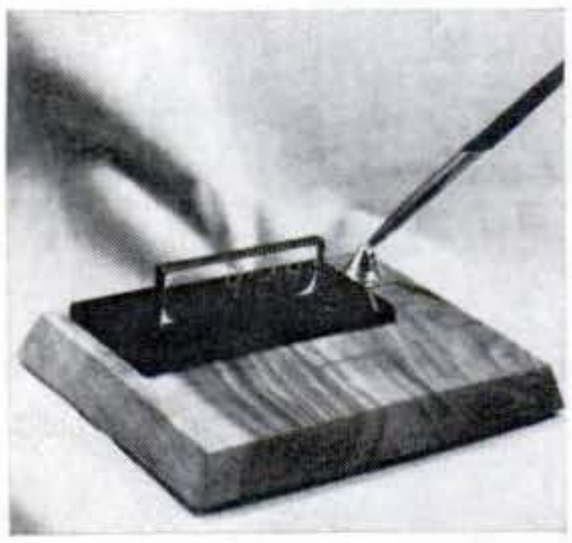
What better way to catch a thief than to have him call the police for you? Connect this Dialtronic phone dialer to your burglar/fire-alarm system, and a prerecorded cartridge tape announces fire or burglary to six dial-in phone numbers. $180 from Mountain West Alarm, 4215 N. 16 St., Phoenix, Ariz. 85016.

Handy digital

A digital clock with hands? Made by LiquidCrystal, Inc., for Bulova, this electronic clock displays the hour digitally and the minute by a pulsating light moving around the permanently etched minute marks. Mirrors? Nope. Face is a single 81-square-inch conductive "cell."

Cartridge player

Five heads are better than one. And RCA proves the point with this MYC-555 five-cartridge playback unit which gives 6½ hours of uninterrupted music for each loading. Each cartridge has its own playback head and can be selected manually or automatically in a cycling mode. The system is $169.95 from RCA.



Sing-along system

Like to sing along with your records? Sanyo's SPT110 lets you do it up right. Along with a stereo phonograph, you get a separate microphone input for joining in. Your voice is amplified and played through the speakers along with your favorite recording. Complete system is $49 from Sanyo Electric.

Pen-set clock

Making a note of the time is easy with this Quarza digital-clock desk set. Inside the walnut base are the digital electronics necessary to keep time accurate to within five seconds a month. A liquid-crystal display reads out time directly. Price: $200. Cox Electronics Systems, Salt Lake City, Utah.

For teachers: pictures that talk

Pictures and sound come together in 3M's new teaching aid, the Sound Page. It's designed to instruct anyone—on any subject—both visually and audibly. On the special sound paper, you glue, tape, draw, or print the visual information you want to teach. Then you place the paper on the desk unit and record questions, information, or details to go with the picture. A rotating record head puts the information on the magnetically sensitive back side of the paper. Placing the desk unit in the playback position allows the head to scan the paper again, this time playing back the information as the student sees the illustration. The Sound Page sells for $299.

Digital stopwatch

No hard-to-read dials on this stopwatch. The Harper Accusplit is totally electronic, displaying elapsed time, down to a hundredth of a second, on easily read digital displays. Split and time-out features make it ideal for all sporting events. It's $175 from Tafco, 401 First St., Los Altos, Calif. 94022.

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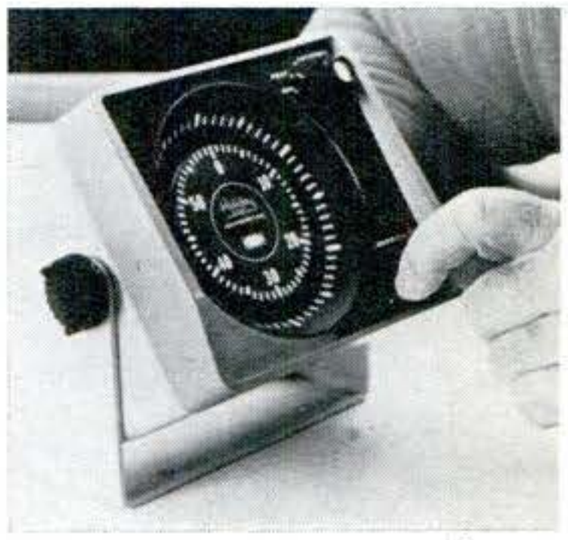
What's New
IN BOATING

Plastic canoe

There's only 75 pounds to portage with this new ABS plastic canoe—complete with built-in cooler and storage compartments—but it has a capacity rating of 940 pounds. The 17-footer shown costs $299; others start at $279. Whitewater Canoe Div., Box 278, Indianola, Iowa 50125.

Jet tow

Swimobile—that's the name of this eight-foot, 80-pound jet-propelled craft that tows you through the water at up to eight mph. It has twin jet pumps and an air-cooled four-cycle Briggs and Stratton engine. Price: $329.50. Minijet Sportscrafts, 122 E. 42nd St., New York, N.Y. 10017.



Three-point hydro

A little over two sheets of plywood form the hull of the eight-foot, 64-pound Tiny Titan. She'll handle up to a 20-hp outboard. Plans for the hot little hydro are $8.50; frame kit, $59. From Glen L Marine Designs, 9152 Rosecrans, Bellflower, Calif. 90706.

Easy-reader

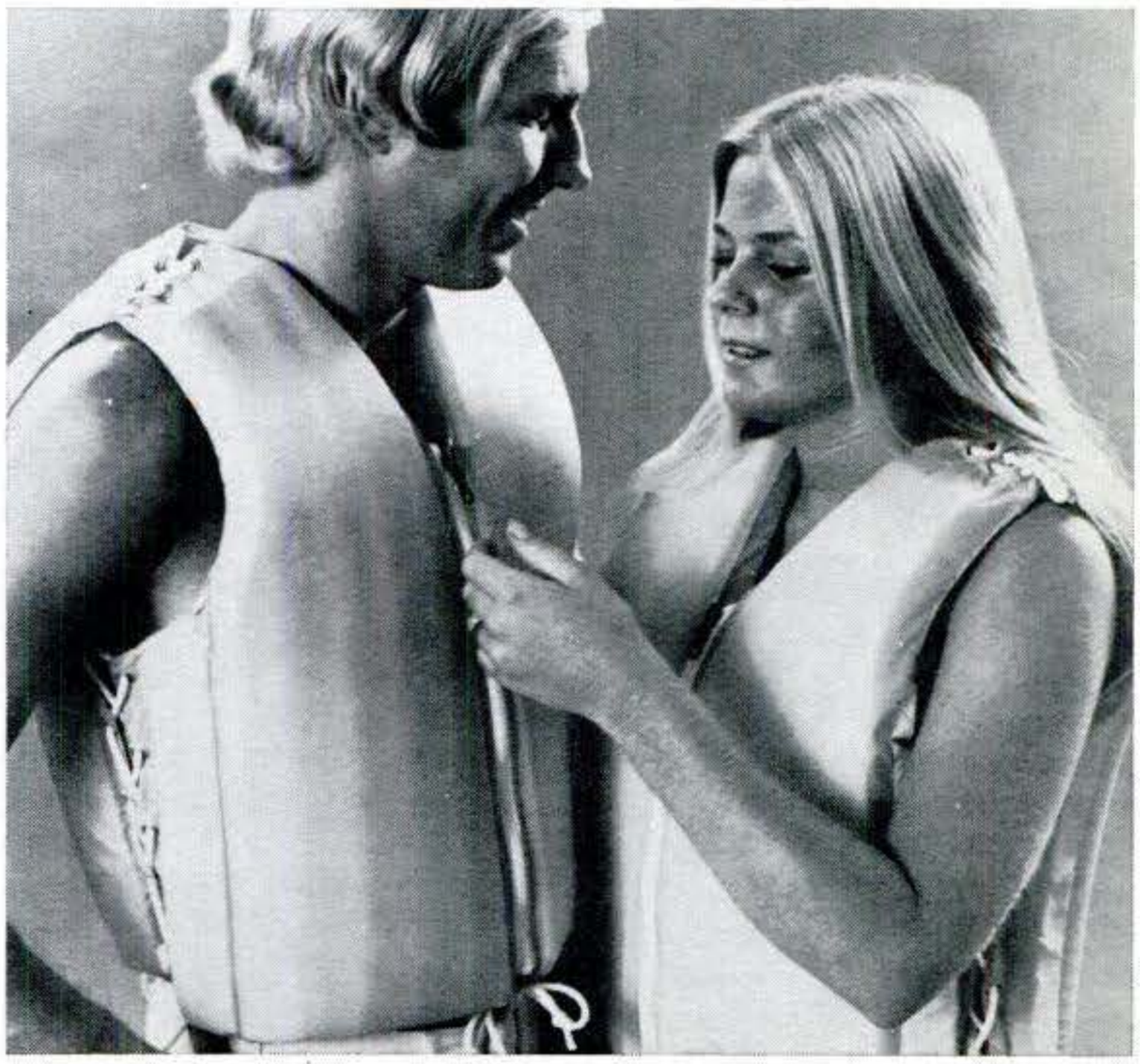
Big problem with depthfinders: They're tough to read in bright sunlight. Now Raytheon has one with LEDs that are easy to see in the sun (or at night) and last 10 times longer than ordinary bulbs. Fathometer measures depths up to 60 feet and costs $165. From the Raytheon Co., Lexington, Mass. 02173.

Runabout

For cruising, towing skiers, or just plain fun, it's hard to beat the new Super Caprice 15, say the MFG Boat people. The deep-V-hulled craft has a beam of 77 inches, a max capacity of 1420 pounds, and an hp rating of 85. $1469 buys one in wild plum, orange, or gold. MFG Boat Co., Union City, Pa. 16438.

Lightweight jacket

Hate wearing life jackets? The Hurricane Vest may be for you. At 15 ounces, it's the lightest CG-approved flotation device around, claims the maker. It has adjustable shoulder and side straps, and is reversible. Price: $17. Maker: Empress Corp., 1144 S. San Julian, Los Angeles, Calif. 90015.



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For a big one: Trailex four-axle TX-4000 hauled this 7800-pound sailer 1500 miles from Ohio to Cape Cod and return. Frame is made of extruded anodized aluminum.

Bass-boat trailer, Gator's Deluxe 060, has flat bed with keel rollers, padded cradles. Bow stop is built "to keep your boat out of your car's back seat."

More rollers, new designs, and power-loading equipment make trailers easier to use, kindlier to the boat

PS BOATING

PS Guide to the New BOAT

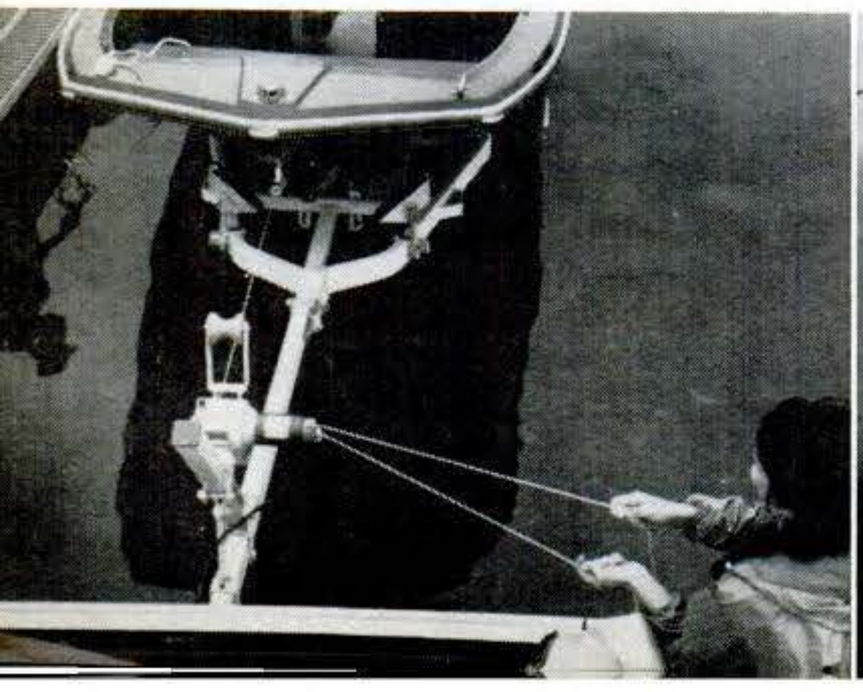
By JIM ROE / *PS Boating Editor*

A boat trailer is the mobile mariner's magic carpet. It's his ticket to boating in a variety of waters anywhere his car will haul one of the popular medium-size boats. Between times, it provides storage, saving him costly slip fees.

What to look for in a trailer? Easy, damage-free launching and loading, trouble-free hauling. There are lots of new ideas in the '73 boat trailers, so let's preview what is being offered and why. To assist you, on a following page is a guide to representative trailer sizes and prices in a number of nationally distributed brands.

Rollers and more rollers. This is the fastest-growing trend. When I got my first boat trailer some 10 years ago, it had six or eight keel rollers, and movable bunks for the remaining hull support. Today, some trailers have no bunks at all, and support the entire hull on a complicated assemblage of rollers. I counted 64 on one trailer!

Author recommends power winch for heavier boats. Superwinch, here, operates safely with remote line controls.



You can attach Powerwinch to trailer hitch with adapter plate. Then you can winch trailer up bank from the water.

The reason: It's a lot easier to roll a boat onto a trailer than to slide it. Another good reason, particularly at the rear of the trailer, is to help center the boat on the trailer even in crosswinds or current, or when handling is imperfect. Hinged brackets bristling with rollers gently guide the bow to its center position.

How do you arrange the rollers to give proper hull support? There are almost as many answers as there are trailer makers.

James Olney of the Trailex Company in Canton, Ohio, was the first to use rollers—he incorporated washing-machine wringer rolls in boat trailers in the late '40s. Today, his Trailex trailers have a pattern of closely spaced keel rollers. Bunks supporting the hull from the transom forward for several feet are still there, but are fitted with up to eight imbedded rollers. Obviously, Olney points out, the more rollers you have, the less weight there is on each, and the boat rolls more easily.

Bunks without abrasion. Holsclaw, another long-time manufacturer, uses another system. With closely spaced keel rollers, there are side bunks at the stern and just forward

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With a little practice you can drive right up. Alloy's keel rollers and toggling side rollers guide boat into place.

TRAILERS

from amidships. Twin sets of rollers extend from either side of a bunk. A single bunk has 15 attached rollers. Holsclaw's Bill Miller explains:

"A boat should be supported along the keel and the chines. We have made the longitudinal rollers fully adjustable in and out, and up and down, and placed them close together to properly support the boat. This roller system allows the boat to be loaded and unloaded easily, and eliminates possibility of the padded bunks gathering dirt along the highway, causing abrasion on the hull." The adjustable rollers will accommodate different hull shapes, from a flat bottom to a deep V, on the same trailer.

A strong exponent of going all the way with rollers is Calkins, a maker in Spokane, Wash. A mixture of paired keel rollers, low-mounted tilting guide rollers at the rear, and paired hull-support rollers from stem to stern do the job. Rollers are of a size designed to climb the strakes of a lapstrake hull. O. C. Calkins says that the roller system is designed so that up to 80 percent of boat weight is supported (or self-supporting) on the keel rollers and rear centering and transom rollers.

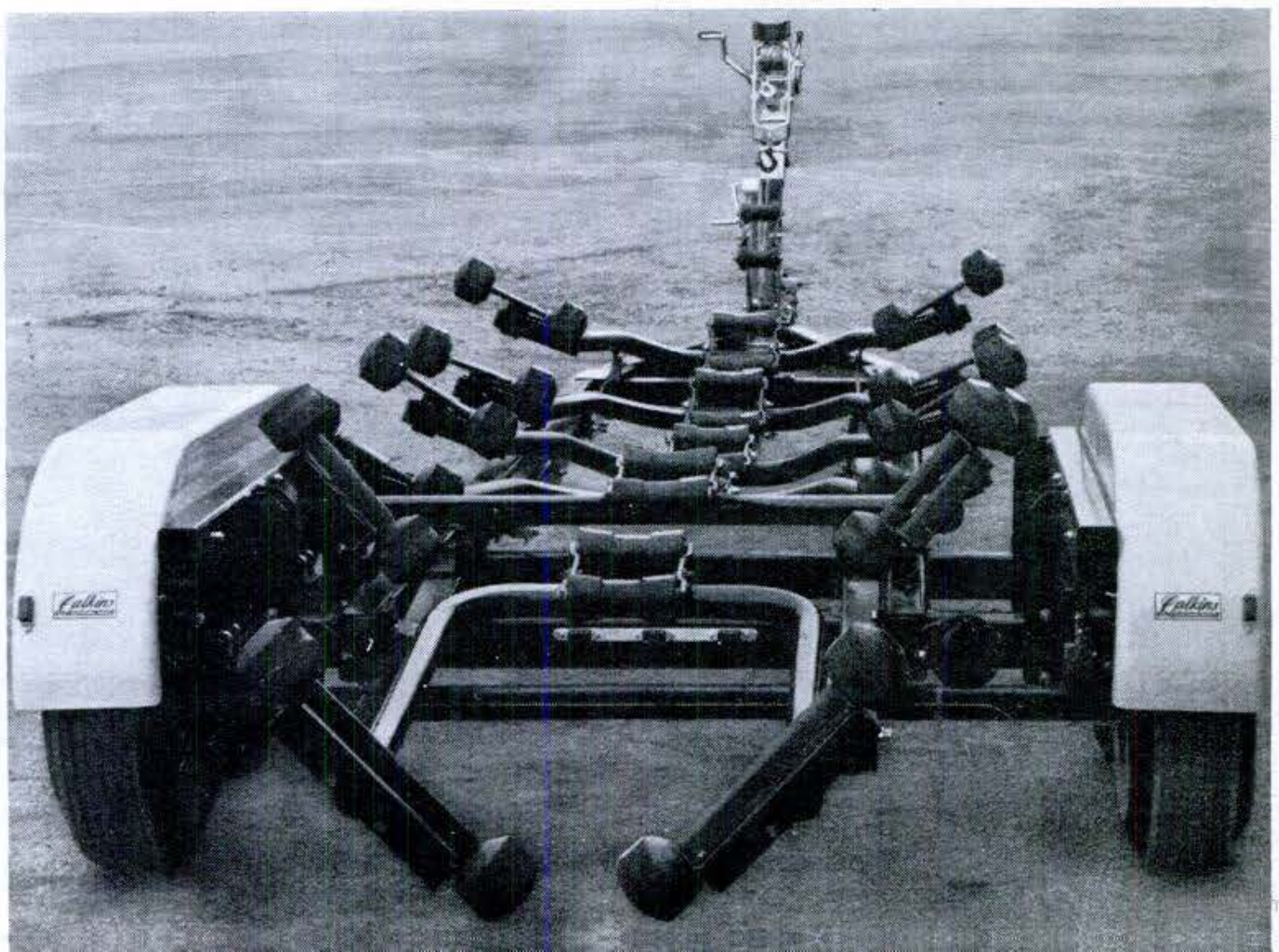
It's not unanimous. Only a few companies feature 100-percent roller support in their entire line. Some long-time trailer manufacturers feel that the keel rollers, aided by padded and adjustable cradles, offer the best support for the hull.

Obviously, a padded cradle snugged against the entire length of a hull gives better-distributed support than even the same cradle fitted with a half-dozen rollers that concentrate the weight at those small points. Builders who use padded cradles usually equip such trailers with levers that raise and lower the cradles, facilitating loading and unloading, and reducing friction.

My own first trailer, a husky Gator, used this system. It was designed

Continued

All-roller system on Calkins trailers features wide rear entry with no exposed bare metal to damage the boat. Most of the weight is supported on keel rollers.



QUICK GUIDE TO REPRESENTATIVE BOAT TRAILERS

Brand and Model	Max. Boat Length	Carrying Cap. (lbs.)	Tire Size	List Price
ALLOY				
F-144	14′	400	4.80 x 8 2-ply	$ 175
F-158	15′	800	4.80 x 8 4-ply	219
F-1825	18′	2500	8.00 x 10 10-ply	480
F-2340T	23′	4000	6.50 x 13 6-ply	828
V-2448T	24′	4800	8.00 x 10 10-ply	1101
BOYER				
500 D	14′	500	4. x 8 2-ply	$ 206
900 D	16′	900	4. x 8 4-ply	277
1500 D	18′	1500	5. x 12 4-ply	368
2200 DVT	18′	2200	5. x 8 4 T	562
2400 DVT	20′	2400	4. x 12 4 T	672
2800	20′	2800	5. x 12 4 T	685
CALKINS				
BC-14	15′	1200	4.80 x 8	$ 250
BC-16	17′	2020	6.00 x 13	355
W-18	19′	2800	E-7.8 x 14	585
W-19	20′	3240	G-7.8 x 14	690
T-19	20′	4600	6.50 x 13	935
T-21	22′	5600	E-7.8 x 14	1005
DT-22	23′	7080	E-7.8 x 14	1230
DT-24	25′	7880	L-7.8 x 15	1360
DT-28	28′	10580	8.00-14.5	1800
GATOR				
119	13′	300	4.80 x 8 2-ply	$ 126
156-S	16′	900	4.80 x 8 4-ply	299
167-D	17′	1200	4.80 x 12 4-ply	316
278	18′	1600	5.30 x 12 6-ply	473
284	19′	1800	6.00 x 9 8-ply	581
285	21′	2500	F-7.8 x 14 "D"-8-ply	773
298-5	24′	5000	F-7.8 x 14 "D"-8-ply	1378
HOLSCLAW				
D-700	16′	700	4.80 x 8 B 4-ply	$ 190
C-900	16′	900	4.80 x 8 B 4-ply	252
D-1475	17′	1500	5.30 x 12 C 6-ply	383
D-1700-18	18′	1700	6.50 x 13 B	474
D-450-17	17′	2300	5.70 x 8 B 4-ply	532
D-475-20	22′	2600	5.30 x 12 B 4-ply	633
C-4000	22′	3600	20.5 x 8.0-10 C 6-ply	918
B-5000	25′	4400	20.5 x 8.0-10 D 8-ply	999
LITTLE DUDE				
340	14′	350	4.80 x 8-A	$ 139
748	15′	700	4.80 x 8	176
1048	16′	1000	4.80 x 8	232
2062DC	18′	2000	6.50 x 13-C	499
2368DC	20′	2300	7.75 x 14	565
5068TDC	25′	5000	7.75 x 14	906
ROAD RUNNER				
A14-4	14′	400	4.80 x 8 4-ply	No list prices
AV15-11	15′	1100	5.70 x 8 4-ply	
AV16-15	16′	1500	5.30 x 12 6-ply	
AV17-20T	17′	2000	5.70 x 8 4-ply	
AV18-35T	18′	3500	6.00 x 9 6-ply	
A20-22	20′	2200	7.50 x 10 10-ply	
A22-25T	22′	2500	5.70 x 8 6-ply	
AV24-55T	24′	5500	7.50 x 10 10-ply	
SHORE LAND'R				
SS-148F	14′	800	4.80 x 8 4-ply	$ 153
SS-1613B	16′	1300	6.50 x 13 4-ply	292
SS-1713	17′	1300	5.30 x 12 4-ply	320
SS-V-1720LR	17′	2000	20 x 8.00-10 8-ply	385
SS-1925	19′	2500	7.75 x 14 6-ply	459
SS-1930T	19′	3000	6.50 x 13 4-ply	573
SS-I-2135T	21′	3500	6.50 x 13 6-ply	721
TEE NEE				
300	13′	300	4.80 x 8″	$ 135
500	14′	500	4.80 x 8″	169
800 W/C	15′	800	4.80 x 8″	215
1000 W/C	16′	1000	5.70 x 8″	266
1400 W/C	17′	1400	5.30 x 12″	348
TV-1900	18′	1900	6.50 x 13″	545
2400	21′	2400	4.80 x 12″	615
3500	22′	3500	6.50 x 13″	866
4500	23′	4500	7.75 x 15″	1320
TRAILEX				
TX-505	14′	500	4.80 x 8 2-ply	$ 270
TX-700	15′	750	4.80 x 8 4-ply	310
TX-1100	16′	1200	5.70 x 8 4-ply	475
TX-1700	18′	1800	5.70 x 8 4-ply	680
TX-2400	20½′	2400	20.800 x 10 6-ply	890
TX-3000	22½′	3000	20.800 x 10 6-ply	960
TX-4000-2X	23′	4000	20.800 x 10 8-ply	1260
TX-4000-3X	23′	6000	20.800 x 10 8-ply	1485
TRAIL-R-CRAFT				
GTH 14	14′	1000	4.80 x 8	$ 174
HF 15	16′	1500	4.80 x 12	279
V 16W	16½′	2070	6.50 x 13B	391
V 18T	18½′	2700	7.75 x 14B	491
V 18TA	18½′	3200	5.30 x 12	563
HV 20TA	21′	4140	6.50 x 13B	699
HDV 24TA	24′	5000	7.75 x 14B	1161

to carry our 22-foot Thompson outboard. Since we had twin 75-hp Johnsons hanging on the transom and built-in tanks for 65 gallons, this was a heavy boat to load and trail. The Gator did it well.

One major trailer manufacturer told me his company is looking into several aspects of the roller question. "We're not convinced that rollers exclusively give the hull support we think it ought to have, particularly for aluminum hulls, because of the pressure at specific points. However, our people haven't done enough work with these questions yet to decide.

"At the Chicago trade show," he continued, "we heard that some boat companies, even fiberglass makers, would be reluctant to maintain their guarantees with that type of support. Whether it's true or false, you have to take a long look to decide whether you're changing from the best support method, which we presently believe is with cradles. Of course, if you ink a roller, you find out how many square inches of support you are getting."

But another reason rollers have come on so strong is their adaptability. Tee Nee's Nick Roman says: "First, we were looking at this type of trailer for use as a dealer's work trailer in the yard, one on which he can load any type of boat, any hull design with a minimum of adjustments. It supports the hull at many, many points —at no point is it being abused." Roman adds that loading and unloading with rollers is 75 percent easier —"if you can imagine that much difference."

Fitting the hull types. Most hull styles can be fitted with a "conventional" trailer. Nick Roman notes that a cross-section on a conventional trailer is straight across. "The deep-V hull takes a different design of trailer. The cross-section is dropped. We call it a drop-center channel. It fits the contour of the V and provides a lower center of gravity.

"Some cathedral hulls, with three or four keels, won't take a deep-V trailer. The fenders will hit the sides of the dropped channel. It will take a conventional trailer. Bass boats? They'll take conventional flat trailers," Roman asserted.

Some manufacturers are making a special bass-boat trailer designed to fit the relatively narrow and shallow cathedral hull of this popular boat design. Gator has come out with a deluxe bass-boat trailer, and next year will probably offer two models specifically for bassers.

Axles and hubs. "Except for a new single-axle job

[Continued on page 159]

Aluminum Trailex trailers can be altered by simply adding or removing rollers, bunks, and in some cases extra axles and wheels. Use of T slot and T bolt permits size adjustments.

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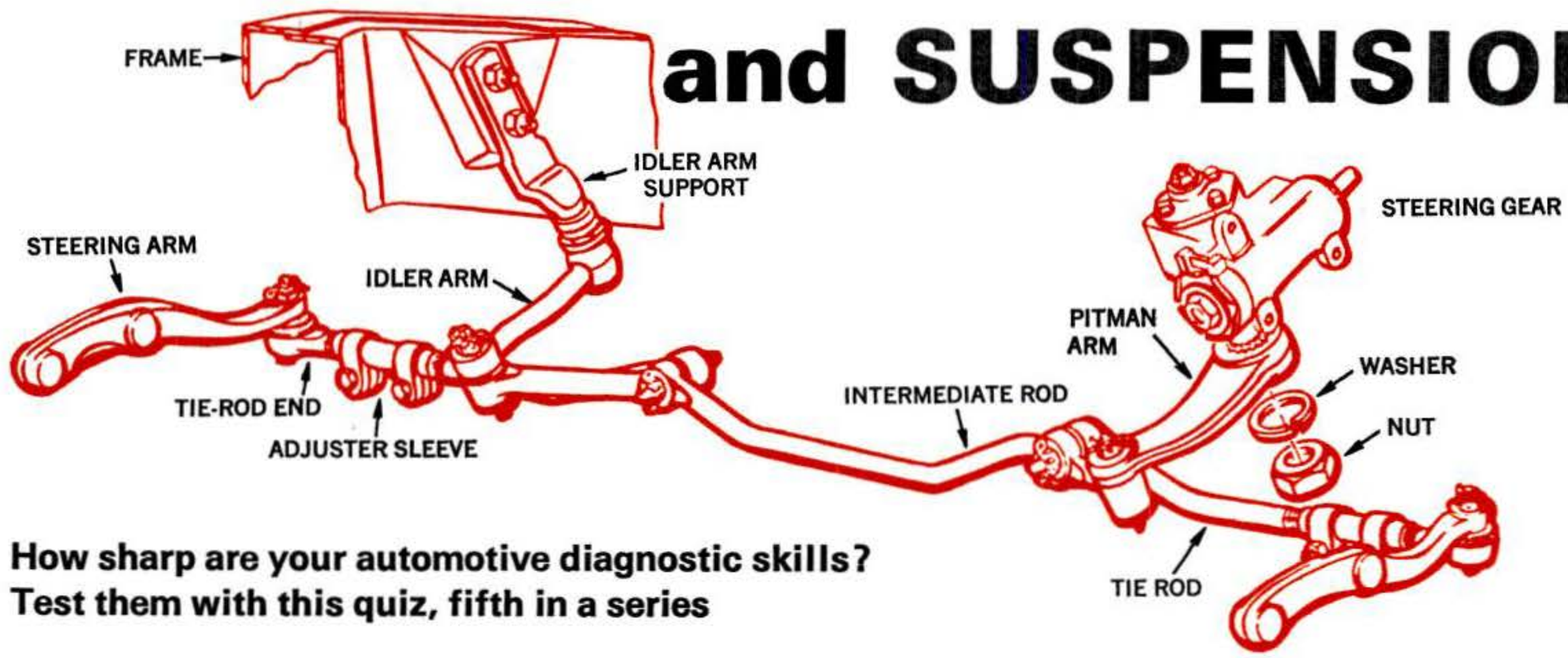
Turning the steering wheel of a typical automobile causes the pitman arm to swing to one side or the other. That movement is transmitted through the intermediate rod and tie rods to the steering arms, which turn the wheels. The tie rods can be adjusted, in or out, for proper toe-in of the front wheels when the car isn't moving. When the car moves forward the toe-in disappears as looseness in the linkage disappears. Steering linkage should be inspected regularly.

Troubleshooting Your Car's STEERING and SUSPENSION



How sharp are your automotive diagnostic skills? Test them with this quiz, fifth in a series

By RAY HILL

1 Car pulls to right while underway

A month ago you bought a 1971 sedan from a used-car dealer. The price was right, the car was clean and looked good. You thought you had gotten a good deal. But now you're not so sure.

The car doesn't want to travel in a straight line. If you relax your grip on the steering wheel for even a moment while underway, the car immediately shoots to the right of the road. Constantly wrestling the steering wheel is not your idea of fun, so you decide to track down the cause of your automobile's headstrong behavior.

First, you inspect the wear pattern of each tire. If the left tire was wearing evenly but the right tire was worn more on the inside than on the outside, this would indicate that toe-in on the right front wheel was not correct. Inspection reveals that both tires are worn evenly and still have plenty of tread. There's no vibration at any speed, so that means wheel misalignment is probably not the cause.

Next, you check tire pressure. Lower pressure in the right tire than the left could cause the right tire to drag more, making the car pull to the right. Your pressure gauge, however, indicates that both tires are inflated to the psi recommended in the owner's manual.

A weak spring on the right side could cause the problem, too. Because the right front of the car would sag more than the rest of the car, more weight would be transferred to the right side, creating more drag. But this, you find out, isn't the cause of the problem: Parking the car on your level driveway, you measure the vertical distance from the center of both outside headlights to the ground with a tape measure. Both measurements are the same.

Another possibility is that the right tire is smaller than the left. Two tires, each made by a different manufacturer, may be stamped with the same size but still not have the same diameter. The only way to be sure is to stand both tires side by side on a level surface and see if one is higher than the other. You don't have to go to this trouble, though. When you bought the car you put new rubber on all the way around. All the tires are from the same maker. So uneven tire height is ruled out as a possibility.

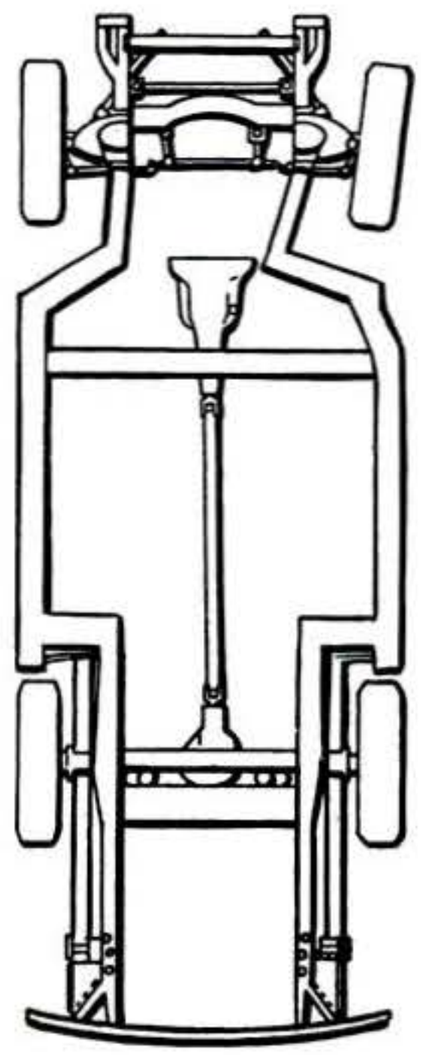
You run back over the list of possible causes in your mind. But you can't think of anything overlooked.

What's the most likely cause of the problem?

Answer

There's a good chance your car was in an accident before you bought it. Although visible damage was repaired, the frame was thrown out of alignment in the accident and not repaired. The solution? Have a body shop check it, and realign the frame if it's bent.

Continued



A frame bent like this can cause a car to pull to right. In cars without complete frames, a severe body dent behind the front wheel can cause car to pull.

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2 Your car pulls left when you apply the brakes

After a leaking wheel cylinder caused replacement of the brake shoes in the left front wheel, you began noticing that the car drifted to the left when you applied the brakes. Removing the left front brake drum and reinspecting the brakes, you find that the rebuilt wheel cylinder isn't leaking and that the new brake shoes are installed and adjusted properly. After putting the drum and wheel back on, you take the car out for a test drive. When the brakes are applied, the left front wheel still pulls to the left. So you decide to look elsewhere for the cause of the trouble.

First you check tire pressure. If the left front tire was low, the car might not drift to the left while driving because the crown in the road would stop it. But because the low tire would present more surface area to the road when brakes were applied, it could cause the car to drift left. This theory, however, is knocked in the head: Both tires have the same factory-recommended psi.

If the tie rods and ball joints were worn, they could cause the problem, because when the brakes are applied the worn joints and rods would allow the relative position of caster and camber to change. Jacking the car up you discover the tie rods and ball joints are in good shape. So that's another theory down the drain.

A different tread design on the left tire than on the right could cause the problem by causing the left tire to adhere more to the road when brakes are applied. A bald tire on the right and a new tire on the left could also cause it. But that's not so in your case. Both tires have the same type of tread, and plenty of it.

Then it hits you. You wonder why you hadn't thought of it before. The right brake drum is probably full of dust. The dust acts as an anti-friction agent, and when the brakes are applied the new clean shoes on the left grab more strongly than those in the right brake drum—causing the car to drift to the left when the brakes are applied. The theory is sound. But it's not applicable in your case. The right wheel cylinder is free of dust.

A loose bearing on the left wheel could be the culprit. But jacking the car up and checking the bearings, left and right, for play reveals none. Both wheels spin freely. So you figure the problem isn't caused by a bad bearing nor by faulty bearing adjustment.

Entrapped air in the right front brake line could be the culprit. You bled the left front line when you rebuilt the left wheel cylinder. But the brake pedal isn't spongy, and fluid level is where it should be. So you assume that the right brake line is okay. The only way to check for sure is to bleed the right front line and see if bubbles come out. But you don't think that's necessary until you've at least exhausted all of the other possible causes that you can think of.

If your brakes were self-adjusting, a possible cause could be that the right adjuster is adjusting normally but the left adjuster is adjusting too tight, so when the brakes are applied the left shoes contact the drum before the right shoes do, causing a momentary pull to the left when the brakes are applied. Your brakes, however, are not self-adjusting, and are adjusted correctly—so that theory is not applicable either.

If your car was old, and you used low-quality brake fluid, you might consider the possibility that the left hose had become contaminated and deteriorated to an extent that its diameter was restricted more than the diameter of the hose on the right.

If that was the case, when the brakes were applied the left brake would be slow to release, and that would account for the car pulling to the left. However, your car is only a year old, you take good care of it and use high-quality brake fluid—so a contaminated hose is really an outside chance here.

What's causing the car to pull to the left?

Answer

When you rebuilt the left front wheel cylinder and replaced the brake shoes in that drum, you caused the problem. The new brake shoes have a higher friction coefficient than the old shoes. When replacing brake shoes on one front wheel, the shoes on the other wheel should be replaced, too.

3 Car wanders on bumpy roads

When you're driving over bumpy roads your car's steering becomes spongy and the car wants to wander. You suspect bad shocks.

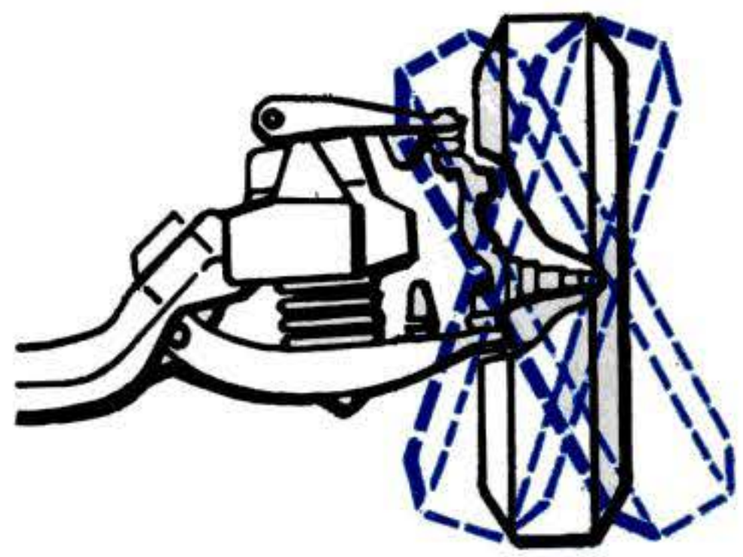
To check, you stand on the front bumper and jump off. The front end bounces only once and then stops. That means the shocks are probably okay. If the car had bounced up and down several times, that would have indicated weak shocks. You try the jumping test from the rear and the same thing happens; the car only bounces once.

How about the springs? Inspecting them with a flashlight, you can see no cracks or excessive distortion. When the car is parked on a level driveway all four corners of the vehicle are an equal distance from the ground. And when you're driving over bumpy roads the springs don't bottom out, which they'd do if they were weak. So bad springs aren't causing the wandering effect.

What's a likely candidate?

Answer

Worn and loose ball joints are the probable offenders here, causing the car to wander. Worn ball joints are dangerous. They should be replaced immediately.



When ball joints are loose they can let wheel travel from side to side. This travel, exaggerated in drawing above, causes car to wander on bumpy roads.

4 Excessive play in steering wheel

In order to turn your manual-steering car left or right you must turn the steering wheel an excessive amount before the wheels respond. Thinking that the steering-gear adjustment is too loose, or the steering gearshaft isn't adjusted tight enough, or is badly worn, you follow service-manual procedures and inspect them. They're okay. And steering linkage isn't loose or worn.

Next, you check the front wheel bearings for play. But they're adjusted properly, so the cause of the problem isn't there. The steering arms aren't loose at the knuckles and the ball joints aren't worn.

What's the most likely cause of the problem?

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Answer

The bolts that hold the steering-gear housing to the frame are probably loose. When you turn the steering wheel the steering box moves out the distance of the loose bolts before the wheels turn. Loose steering-box bolts are extremely dangerous. If all the bolts work loose or break while you're driving down the highway, you'll suddenly find yourself without any way of controlling your car.

Excessive play in the steering wheel should always be investigated and corrected immediately. The culprit may be nothing more than a steering gear that needs tightening. Then again, it may be something much more serious.

5 Vibration at a certain speed

Two weeks ago you were almost in an accident. Another car was passing a truck and headed directly toward you in your lane. You had only two choices—a head-on collision or the ditch. You chose the ditch.

Fortunately you bounced across the ditch and back on to the road without injury. You stopped, yelled a few unprintable epithets at the insane driver who had disappeared, and then looked over your car. There were no dents or scratches that you could see, so you climbed back in the car and drove home.

On the way, you notice that between 50 and 55 mph the car vibrates violently. When traveling above 55 or below 50 there is no vibration. It occurs only within that five-mph range.

There are several likely candidates that could be causing the vibration: one or both front wheels out of balance, one or both rear wheels out of balance, worn ball joints, worn universal joint, or misalignment of the transmission output shaft to the drive shaft.

There's one other candidate, too. And because the vibration happened just after running off the road, there's a good chance that this one is guilty of causing the trouble. What item is it?

Answer

When you went off the road and bounced across the ditch, there's a good chance you bent the drive shaft. But a bent drive shaft is better than a head-on collision—any day. Automobile parts can be replaced. You can't.

6 Tires squeal when turning

Driving on a road filled with potholes, you hit one with such force that the front shocks bottomed out. But you still had front wheels.

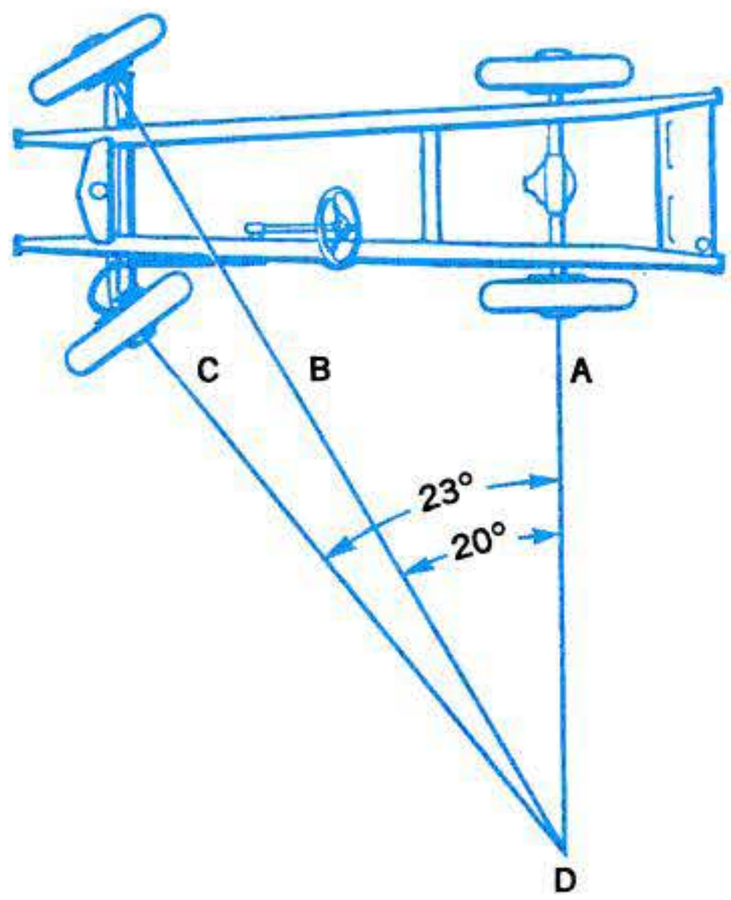
Now when you make a left or right turn, even at slow speeds of 15 or 20 mph, your tires squeal as if you were sliding around a curve too fast. The squealing definitely isn't a result of excessive speed and only happens when you turn. What's causing it?

Answer

Toe-out alignment during turns isn't correct. That's why the tires squeal when you turn, even if you're not traveling fast.

Remember that pothole you locked horns with? It probably bent a tie rod or steering arm, most likely the tie rod (it's not as strong as the steering arm).

Solution? Have the wheel alignment checked; replace the tie rod or steering arm if necessary.



Inner wheel during a turn is at a sharper angle (C) to the car frame than outer wheel (B). This allows it to travel a shorter radius than outer wheel.

7 Excessive tire wear

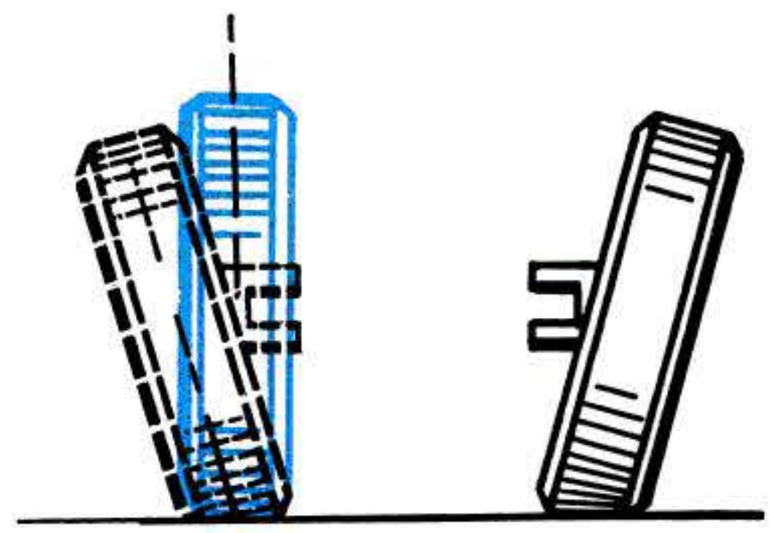
There's no vibration that you can detect. And your car steers and handles acceptably. But the inside of the right front tire is wearing more than the rest of the tire.

What's causing it, and what should be done about it?

Answer

Excessive camber is the cause. The solution is to have the wheels realigned. If the tire is worn badly it should be replaced. Proper wheel alignment and tire balancing are very important for smooth, safe driving.

Improper wheel alignment can ruin a set of new tires in a very short time. After even a minor front-end accident, it's a good idea to check wheel alignment to make sure it's still okay. PS



Most cars use positive camber: Tops of wheels tip out from vertical (exaggerated here). When wheel loses camber, as at left, excessive tire wear results.

TIRE-WEAR PATTERNS

CONDITION	CAUSE
RAPID WEAR AT SHOULDERS	UNDER-INFLATION
RAPID WEAR AT CENTER	OVER-INFLATION
CRACKED TREADS	UNDER-INFLATION OR EXCESSIVE SPEED
FEATHERED EDGE	INCORRECT TOE
BALD SPOTS	WHEEL UNBALANCED

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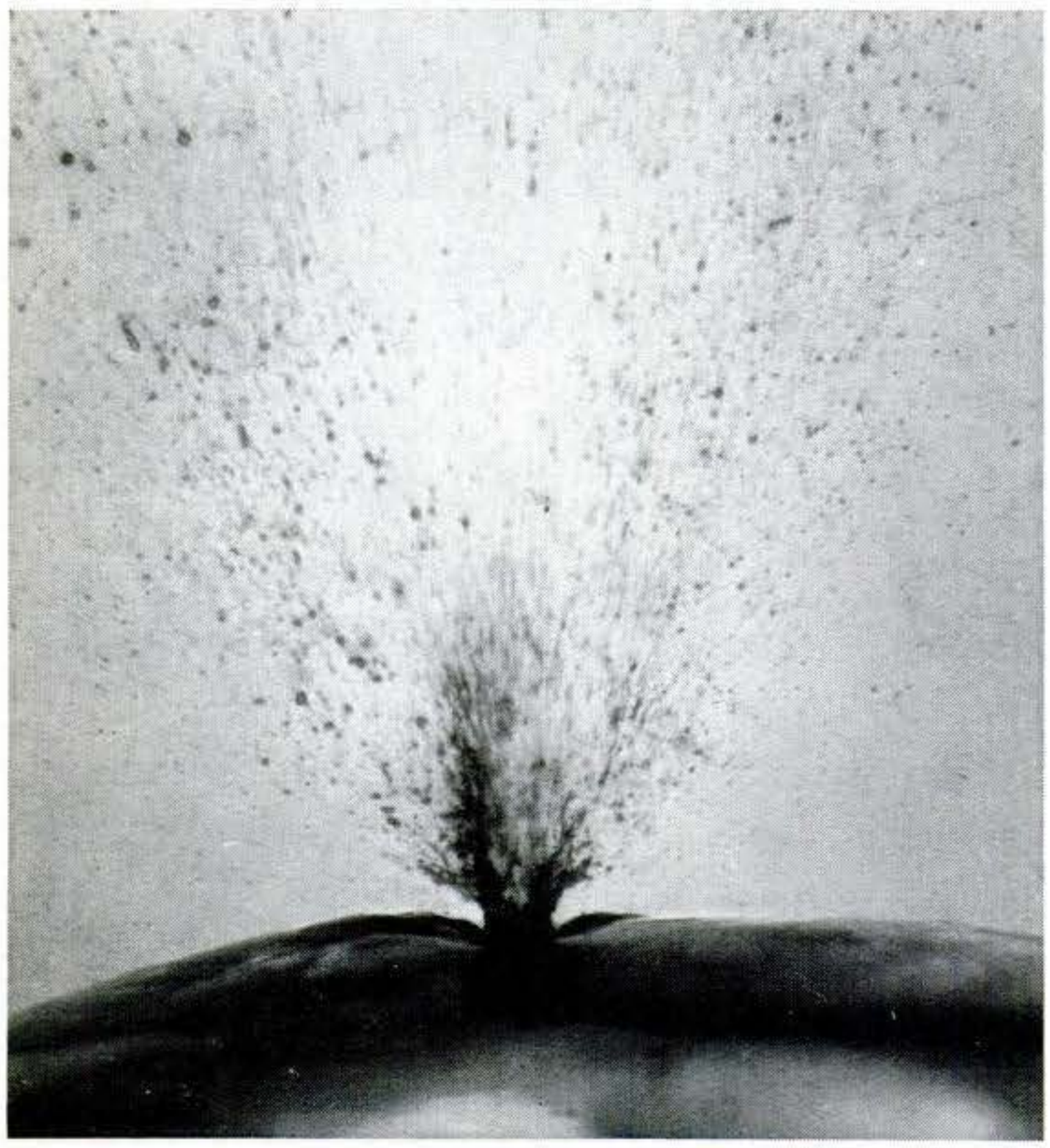
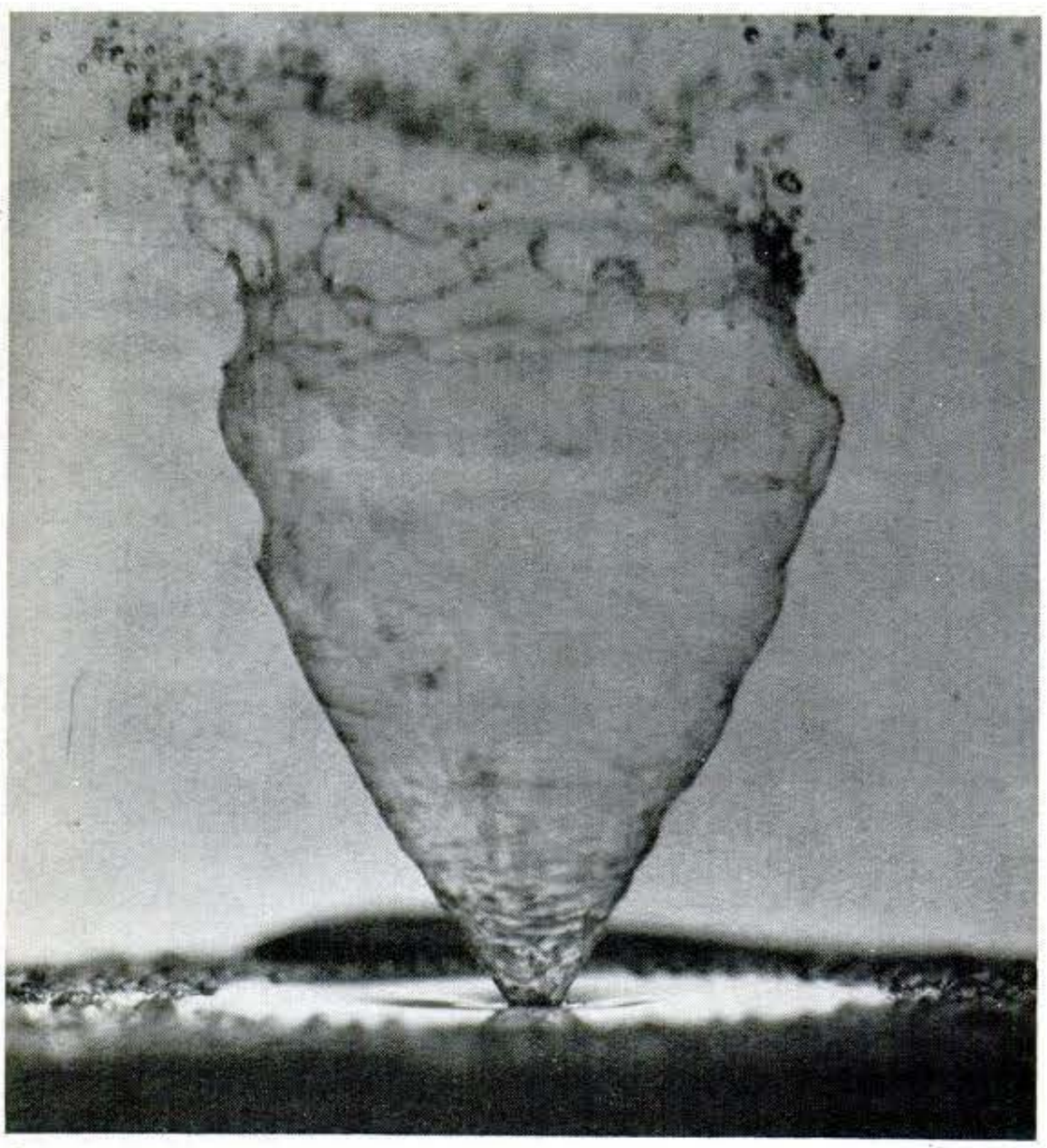
What makes coffee coffee-er, houses cozier, breathing easier?

It's SUPERSPRAY



Babington nozzle atomizes liquid film directly into droplets. Result is very fine, uniform spray.



Conventional atomizer sprays in solid tulip pattern; this breaks into streamers and random-size droplets.

By SIMON DRESNER

In a basement workshop in suburban McLean, Va., I watched anxiously as my host held up a small, hissing glass sphere nestled in a beaker of kerosene. He struck a match, brought it into the sphere's spray pattern, and–*whoosh!*–a four-foot-long tongue of flame shot across the room. Incredibly, the half-inch glass ball had turned into a dragon-like flame thrower.

And more wonders were to come. I was looking at an ingenious and revolutionary new invention–a device that can spray just about any liquid with complete ease and utter uniformity, and can generate, if desired, a mist as fine as cigarette smoke.

Its inventor, Robert S. Babington, calls his brainchild a nebulizer. Based on an entirely new engineering principle, it has already solved many difficult spray problems, and promises to have exciting future applications, including:

- A simple, efficient oil burner that can never clog, and gives more even and more complete burning because of the very uniform spray.
- An emergency field burner that can digest any fuel from syrupy diesel oil to thin kerosene or gasoline.
- An insecticide fogger about 10 times more effective than present models–and at least 10 times less polluting as well.
- A life-saving mist generator for patients suffering from asthma, emphysema, and other severe respiratory diseases.
- A humidifier that can blanket a room with a cloud of vapor–in minutes.
- A spray for soup and tea concentrates that can produce dry, powdered products.
- A spray for perfumes or fragrances to add realism to exhibits.
- A spray for coating coffee oil onto powdered coffee to give it a freshly ground flavor.
- A precision, waste-free paint sprayer for assembly-line products.

The Babington nebulizer is basically a glass sphere a half inch or so in diameter, with one or more thin slots cut into it. The liquid to be sprayed is allowed to flow over the surface of the ball as a thin, uniform sheet. When air under pressure is pumped into the sphere, it passes through the slots and blows the film of liquid that is directly over the slot into a fine spray. The six-foot-long cloud of spray spewing from the tiny glass sphere must be seen to be believed.

For Babington, a former top engineer with NASA's Apollo space program, necessity was the mother of invention. "When my family moved to the Washington area," he says, "my wife and children developed all kinds of respiratory allergies, such as hay fever. The first thing the doctor said was to get a humidifier. So I installed a simple wick-type evaporative plate humidi-

Continued

* 113 [illegible] Ave, McLean, Va. 22101

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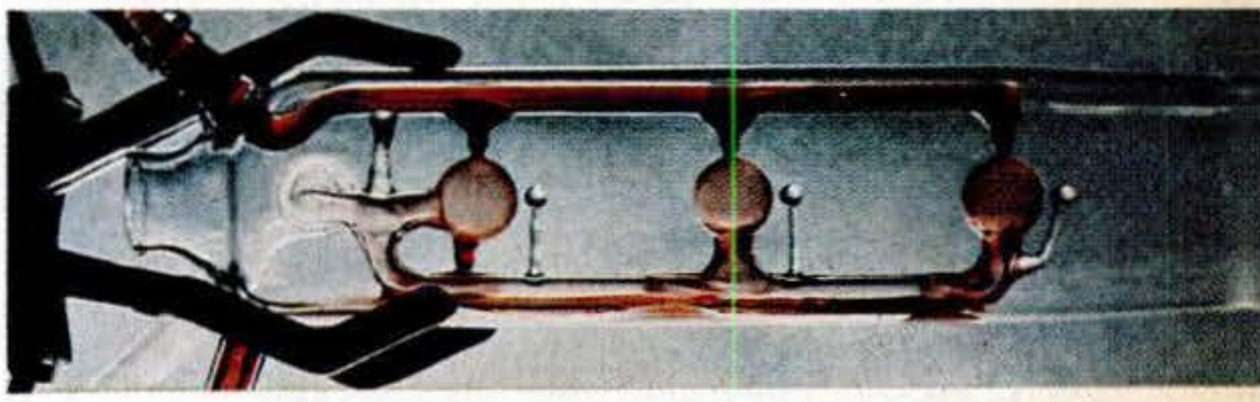
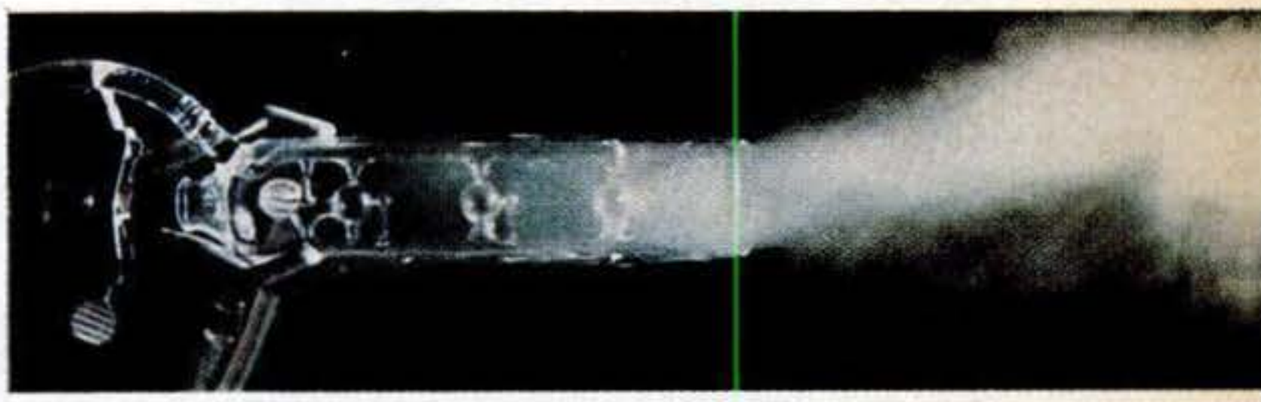
From fine spray to superfine fog: Basic nebulizer (photo at top) gets shroud (middle), then shroud plus hose.

Spray spurts from lab nebulizer as air under pressure shoots through slot in glass sphere, atomizing thin liquid film.

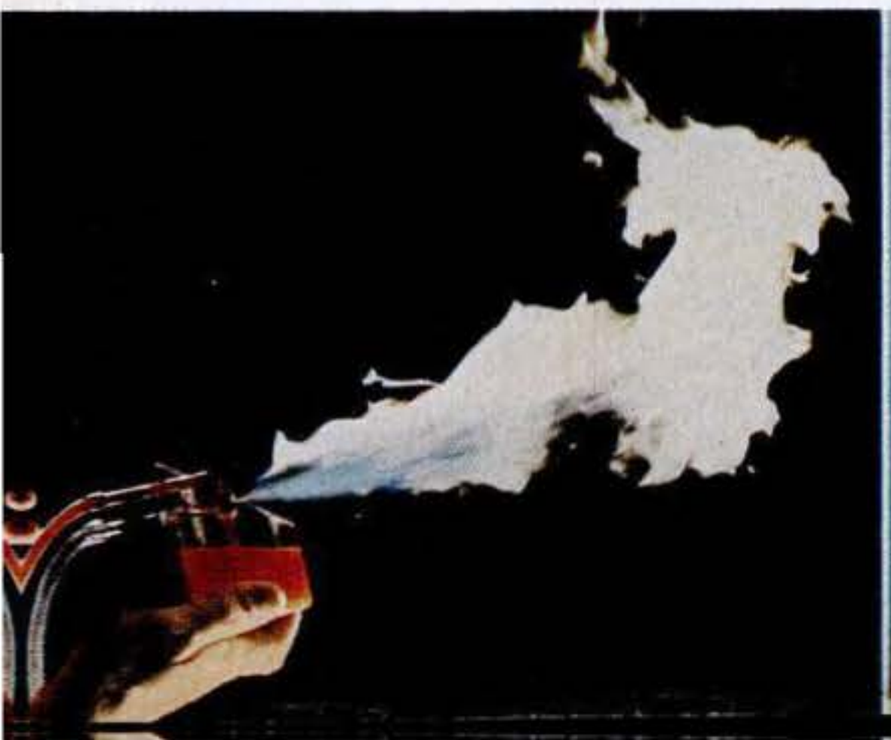


Impactors—small balls in front of slots—shatter droplets after they are formed, reducing particle size of spray.



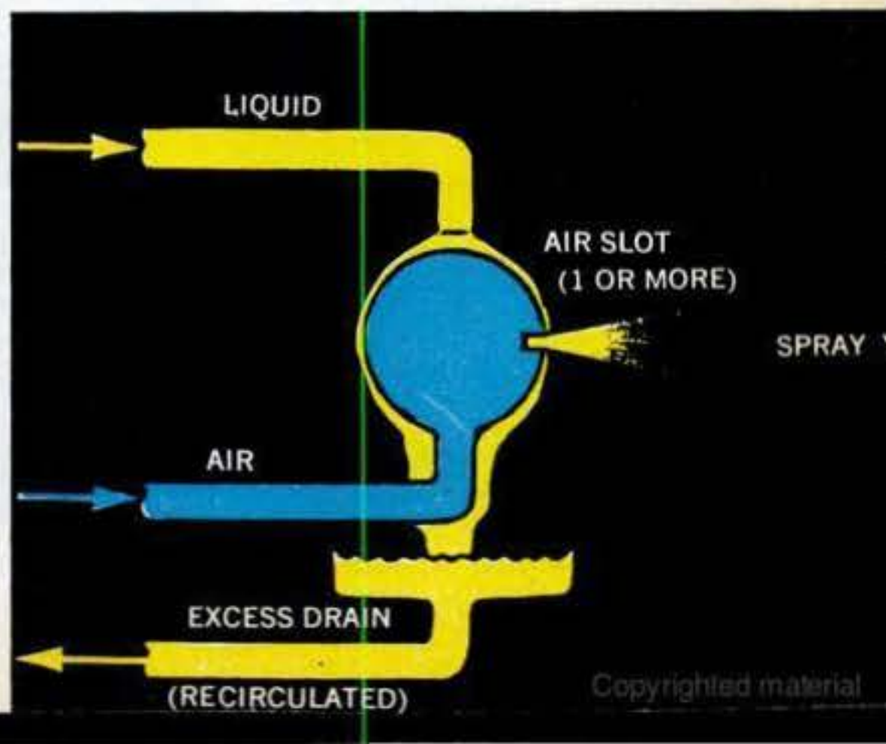
Aerosol produced by model with impactors is smokelike—so fine it glances off a mirror's surface without wetting it.

"Flamethrower" spouts huge gout of burning kerosene from simple nebulizer.



Model of home oil burner works fine using primitive parts like aquarium pump.

Surface tension is key to basic concept: It stretches liquid film thin.



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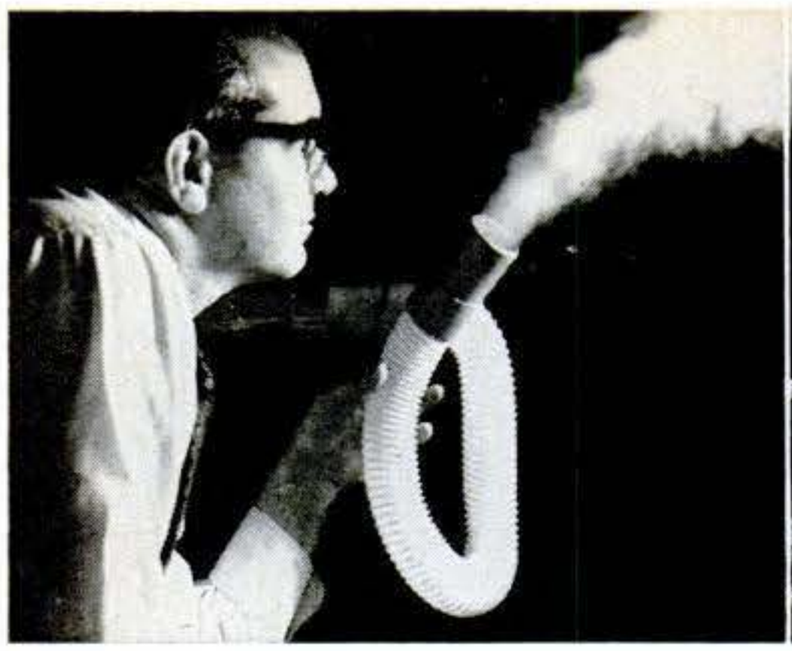
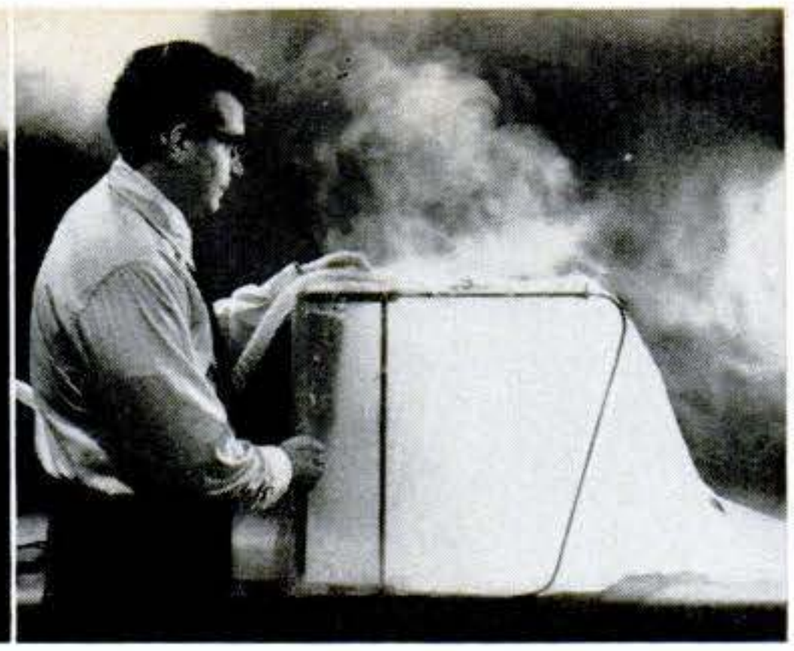


Hose over shrouded nozzle yields superfine mist or fog. Kink in hose is deliberate; it traps larger particles.



Mist tent—for treating respiratory ailments—is enclosure with hose inside. Mist is so fine patient would stay dry.

fier in my heating system, but it didn't put out anywhere enough moisture. As I've always been a do-it-yourselfer, I started to build my own humidifier. While tinkering with my home aquarium one day, I used the tiny aquarium compressor to bubble air through some air stones. I got the same fizzing action that you get on top of a glass of carbonated beverage. I thought some such device might work just as well as my home plate humidifier."

The idea develops. He batted the idea around with a friend, and they put some pinholes in a length of plastic aquarium tubing and connected it to the air pump. "Underwater, we just got streams of bubbles," he recalls, "but when we lifted it out of the water, the film of water that remained on the tube slid down over the pinholes, intersected the air stream, and we got a very nice fog."

It took Babington nearly six years to develop his discovery into a usable, patented, profitable device. "After you get a new idea," he says, "the immediate enthusiasm is high. But within weeks, it drops way off and you have to be very persistent to pursue it. It requires about two percent inspiration and 98 percent perspiration to follow through." At first, he continued to work full time for NASA and the AEC, while burying himself in his basement workshop late into the night. The device seemed so promising that he made the big decision: He quit his job, obtained the help of a glass blower and a patent lawyer, and began working day and night to perfect his invention.

Babington explained to me just how his nebulizer differs from conventional atomizers or garden-hose type sprayers. "In a conventional perfume-type atomizer or spray gun," he said, "the liquid is sucked up and then forcefully broken up by the total pressure of the gas." Babington showed me some high-speed photographs of conventional nozzle sprays and pointed out where the liquid first forms a tulip or film-like cone, which then breaks into streamers, or ligaments. The ligaments shake apart into randomly sized droplets (see photos, p. 102). But forcing a liquid through a tiny orifice takes energy. Breaking it up into streamers and droplets takes more energy.

"In my device," says Babington, "the liquid flows gently over the surface of the sphere, with no energy expenditure. This thin film is ruptured by passing air through it, so that I can make droplets directly from the thin film without going through the tulip and ligament stages."

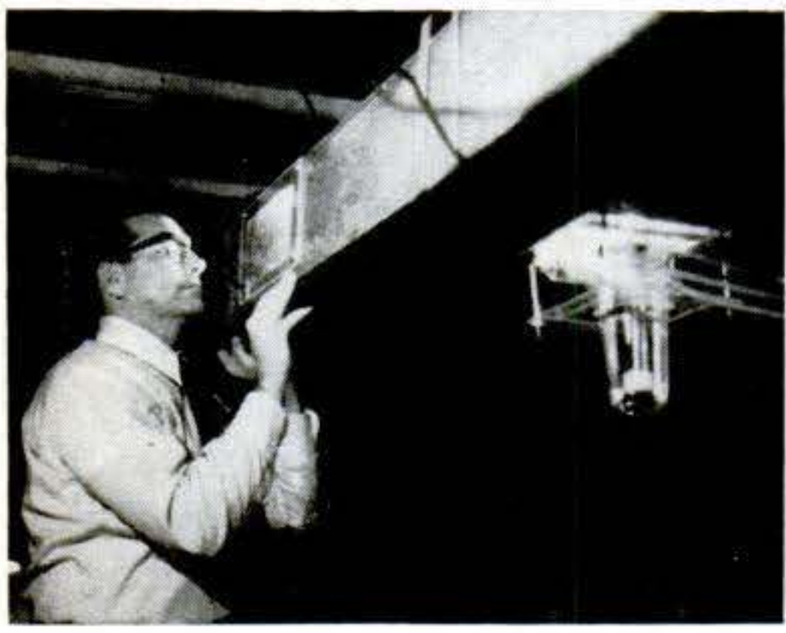
To demonstrate, he held up his basic device, a glass ball welded to the end of an air tube, with a second glass tube over the ball to flow the liquid down over it. The entire device was suspended within a beaker to catch the liquid overflow. "If we spread the liquid right at the North pole of this ball," he said, "it will spread over the ball in a thin film, like a stocking pulled over a darning egg. It's a wetting phenomenon that is determined more by the surface tension of the liquid than by its viscosity. This turns out to be quite an advantage, because although the viscosity of different hydrocarbon liquids varies greatly—crude oil is much more viscous than gasoline—their surface tension is pretty much the same. They're all good wetting agents, which is why they're all good lubricants, regardless of how thick they are. Consequently, I can create a uniform spray with the least viscous to the most viscous hydrocarbon liquids."

If it pours, it'll spray. "The device will spray anything that wets the glass," says Babington. "I've burned every kind of fuel, including crude oil, even with 50 percent water. This includes kerosene, diesel oil, heating fuels, paint thinner, lacquer—I haven't found a hydrocarbon liquid that I couldn't spray and couldn't burn.

"The military have looked at the device for use as a field generator that could burn any handy fuel—they wanted to use whatever type of fuel was available. Trucks and cars use gasoline, some trucks use diesel fuel, aircraft use JP4 or JP5. They wanted to be able to throw any kind of fuel into this burner, thick or thin, in hot or cold weather. As you know, some fuels become very thick in cold weather. When you try to force a viscous liquid through a conventional nozzle, you need a brute-force technique. With my device, if I can pour it, no matter how thick, then I can spray it."

Shrugs off dirt. The military al-

[Continued on page 162]



Through observation port, Babington watches his spray-nozzle humidifier working inside heating duct (detail at right) in his home. Experimental model atomizes about 15 gallons a day, enough to keep his whole house comfortable.

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Plastic Bike Breaks the Weight/Price Barriers

It's a bicycle breakthrough . . . . a 17-pound 10-speed for under $100. And it's American-made, at that

By A. J. HAND
PHOTOS BY ORLANDO GUERRA

Talk about a 17-pound bike today and chances are it's an expensive, limited-production, track racing bike. No brakes, a single gear . . . stripped to the bone. Things are changing though. Soon—maybe as early as August—you'll be able to buy a 17-pound bike of another breed: Priced under $100, complete with 10-speed gearing and caliper handbrakes. Mass-produced in America out of plastic.

When I examined a prototype of this Original Plastic Bike early in March, its plastic chainwheel, chain, brakes, and derailleur weren't ready. Neither were the proposed alloy rims and cotterless cranks. But even with substitute components in place—most of them heavy steel—the bike weighed in around 21 pounds. This is about as light as any 10-speed at any price.

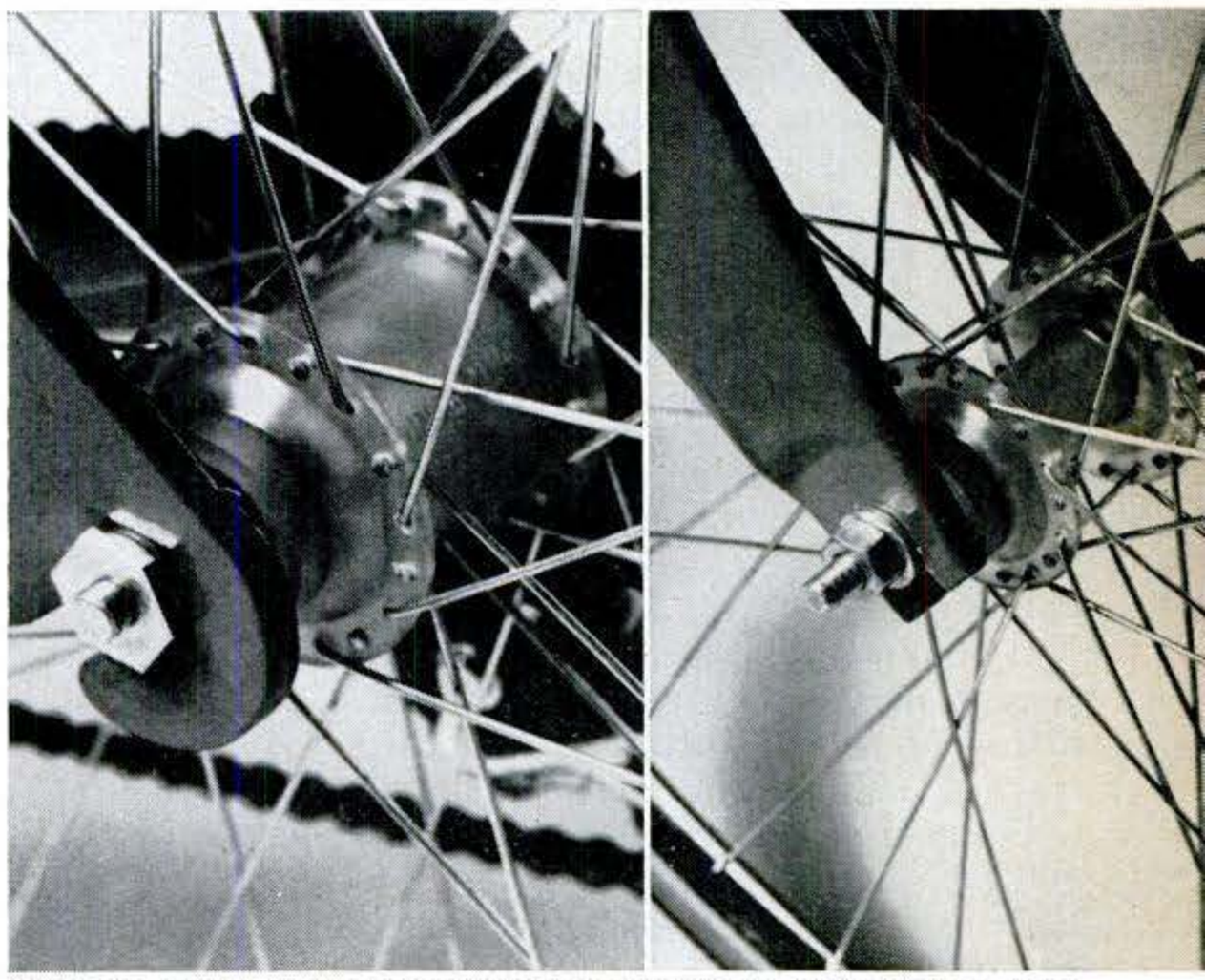
How is it made? In the bike I saw, the frame, forks, and handlebars were all made by injection-molding a special foamed formula of G.E.'s Lexan. Front and rear hubs and the freewheel were also molded Lexan, but did not appear to be foamed. By the time the bike reaches full production, its makers will be using a large family mold that can cast frame, forks, and bars simultaneously—along with all the plastic components in multiples of eight. This means that for every bike made, they'll have seven extra sets of components. These they'll sell to other bike makers.

This molding system has several advantages: Color goes right into the plastic so no painting is required. Serial numbers are inset deeply into the frame. Any attempt to remove them would ruin the bike. Labor costs are way down. The makers estimate they'll have about a buck and a half in labor costs in each bike.

Yes, but will it hold up? Anyone familiar with Lexan shouldn't worry about the strength of this bike. The stuff is just about unbreakable. In tests, the frame has supported thousands of pounds without damage. The plastic hubs have been tested for 3000 continuous miles without signs of wear . . . without lubrication.

The prototype I saw wasn't a working model. I didn't get a chance to ride it. I doubt the Lexan will have the lively response of butted Reynolds tubing, but most buyers will be happy to give up that feel for the savings in weight and purchase price. If you're one of them, you can get more information on the Original Plastic Bike from Original Plastic Bike, Inc., 200 Garden City Plaza, Garden City, N.Y. 11530. PS

Prototype of the Original Plastic Bike is an easy-to-lift package for its originator, Joseph Sorrity. Although this prototype had many steel parts, final model is scheduled to have plastic frame, forks, handlebars, gears, chain, hubs, and derailleur. Rims and cranks will be alloy.



Plastic hubs at front and rear are 36-hole wide-flange type, fully interchangeable with those on standard 10-speeds. They'll run with steel axles and plastic ball bearings, and like the proposed plastic chain will require no lubrication. Gearing on the 10-speed will be wide-range with 47 and 52 teeth on the chainwheels and a freewheel cluster with 14, 17, 21, 26, and 31 teeth. That gives you a very low low gear.

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DISCOVER AMERICA

PS' New Guide to Great Science

Here are nearly 300 great vacation spots where you can see top collections and exhibits in seven fields of interest with special appeal to Popular Science readers

By HERBERT SHULDINER

Did you ever see a World War II fighter plane up close, a 1903 White Steamer, or John M. Browning's original gas-operated machine guns?

If you haven't, here's where to find them when you're traveling around the country on vacation this year. The editors of POPULAR SCIENCE have selected nearly 300 science and technology attractions in the United States and Canada. Over one-third of them are free, and the majority of the others charge nominal admission fees.

While many of these places show things from the past, quite a few are as up-to-date as your morning newspaper. One such place is the Alabama Space and Rocket Center in Huntsville: Dr. Wernher von Braun calls it the best facility of its kind in the world. You can see a giant Apollo-Saturn V moon rocket there that is as long as a football field.

We've divided the nearly 300 places into seven categories—each represented by a distinct symbol shown in the key at the bottom of the map. You can find the places that interest you by picking out the appropriate symbol nearest your home, or the area you're visiting.

Then turn the page to look up the exact location in the index. Where possible, we've shown when the facilities are open, along with their fees—and whether they require advance notice.

If you want a large 18-by-26-in. version of the map at right, with a listing of all the attractions on it, there is a coupon on page 109 along with information on how you can get such a map plus a copy of the Rand McNally Atlas specially printed for PS readers.

The folded map is designed to fit in your glove compartment for easy access as you travel. Together with the popular Rand McNally Atlas it makes a great idea kit for novel vacation trips.

POPULAR SCIENCE 1973

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and Technology Attractions

Nearly 300 places across North America are pinpointed on this map by seven symbols to direct you to your special interests

Want a giant-size copy of this map? Turn the page for details

KEY TO MAP SYMBOLS

- AEROSPACE
- MARITIME
- ASTRONOMY
- TECHNOLOGY
- WEAPONRY
- TRANSPORTATION
- SCIENCE

For a complete listing of all places shown, please turn the page

SCALE OF MILES

ONE INCH EQUALS APPROXIMATELY 229 MILES

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TRAVEL MAP OF THE UNITED STATES

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PS travel guide for '73 pinpoints nearly 300 places in the U.S. and Canada

AEROSPACE

1. **Ala.:** Ft. Rucker — U. S. Army Aviation Museum. Closed Christmas day. Free.
2. **Ala.:** Huntsville — Alabama Space and Rocket Center, Tranquility Base. Closed Christmas. $1.90; child, 85¢.
3. **Calif.:** Buena Park—Movieworld Planes of Fame, 6920 Orangethorpe Ave. $2.75.
4. **Conn.:** Windsor Locks — Bradley Air Museum, Bradley Intl. Airport. Closed Oct. 1—May 15 (except weekends Jan. 1—Mar. 1). $1; child, 50¢.
5. **Fla.:** Kennedy Space Center — Closed Christmas. $2.50; child, $1.25, 50¢.
6. **Ind.:** Indianapolis — Detroit Diesel Allison Powerama, 4700 W. 10 St. Closed weekends. Free.
7. **Iowa:** Ottumwa — Airpower Museum, 3 mi. NW of Blakesburg. Donation.
8. **Maine:** Andover—Telstar Space Museum.*
9. **Miss.:** Bay St. Louis — NASA Miss. Test Facility. Closed weekends. Free.†
10. **Nebr.:** Bellevue — Strategic Aerospace Museum, 2510 Clay St. Closed New Year, Easter, Christmas. Free.
11. **N. M.:** Hobbs — Confederate Air Force Flying Museum, U.S. Rte. 62.*
12. **N. Y.:** Hammondsport — Glenn H. Curtiss Museum. Closed Sun. 50¢; child, 25¢.
13. **N. Y.:** Rhinebeck — Old Rhinebeck Aerodrome, Stone Church Rd. Open daily, May 15—Oct. 31. $1; child, 50¢; Sun. air show: $3; $1.
14. **N. C.:** Manteo — Wright Brothers Natl. Memorial, near Kitty Hawk. Free.
15. **Ohio:** Dayton — U.S. Air Force Museum, Wright-Patterson AFB. Closed Christmas.
16. **Tex.:** Harlingen — Confederate Air Force Museum, Rebel Field. $1; child, 50¢.
17. **Tex.:** Midland — Pliska Aeroplane Mus.
18. **Tex.:** San Antonio — Edward H. White II Mem. Museum, Brooks AFB. Closed Sat., Sun., hols. Free.
19. **Va.:** Hampton — Langley Research Center. Closed Mon. Free.
20. **Va.:** Bealeton — Flying Circus Aerodrome, Rte. 1. $1 (museum), $2.75 (shows); child, 50¢; $1.50.
21. **Nfld.:** Gander — Atlantic Conquest Museum, Intl. Air Terminal. Free.

MARITIME

22. **Conn.:** Mystic — Mystic Seaport, Greenmanville Ave. Closed Christmas and New Year. $3.50; child, $1.50.
23. **Ga.:** Savannah — Ships of the Sea Museum, 503 E. River St. $1; child, 50¢.
24. **Maine:** Bath — Marine Museum & Shipyard. $1.50; child, 40¢.
25. **Maine:** Searsport — Penobscot Marine Museum, Church St. Open June 1—Sept. 30; closed Sat. $1; child, 25¢.
26. **Mass.:** Cambridge — Hart Nautical Museum, 55 Massachusetts Ave. Free.
27. **Mass.:** Fall River — Marine Museum, 70 Water St. $1; Child, 50¢.
28. **Mass.:** New Bedford — Whaling Museum, 18 Johnny Cake Hill. Open June 1-Oct. 1, except Mon. $1; Child, 50¢.
29. **N. Y.:** Sag Harbor — Suffolk County Whaling Museum, Main St. Open May 15-Oct. 1. 50¢; Child, 25¢.
30. **N. C.:** Beaufort — Hampton Marine Museum, 120 Turner St. Apr.-Oct., closed Mon.; Oct.-Apr., closed Mon., Fri. Free.
31. **Ore.:** Astoria — Columbia River Maritime Museum, 16 & Exchange Sts. Closed Mon. Nov. 1-May 1. 50¢; child, 25¢.
32. **Ore.:** Newport — Ore. State U. Marine Science Center. Closed Christmas. Free.
33. **Va.:** Newport News — Mariner's Museum. Closed Christmas. $1; child, 50¢.
34. **Wisc.:** Manitowac — Maritime Museum, 402 N. 8 St., Closed Christmas, New Year. 75¢; child, 25¢.
35. **Ont.:** Toronto—Marine Museum of Upper Canada, Exhibition Park. 50¢; child, 25¢.

PLANETARIUMS AND OBSERVATORIES

36. **Ala.:** Florence — Florence State U. Planetarium & Observatory. $1; child, 25¢.†
37. **Ariz.:** Flagstaff — Lowell Observatory. Closed Sat., Sun., hols. Free.
38. **Ariz.:** Tucson — Kitt Peak Nat'l. Observatory, Rte. 386. Free.
39. **Calif.:** Palomar Mountain — Palomar Observatory. Free.
40. **Calif.:** Los Angeles — Griffith Observatory & Planetarium, Griffith Park. Closed Mon., Christmas. Halls of science, free. Planetarium, $1; child, 50¢.
41. **Calif.:** Pasadena — Mt. Wilson Observatory, Angeles National Forest.*
42. **Colo.:** Denver — Chamberlain Observatory, E. Warren Ave. & Filmore St. Open nights Tues., Sat. Free.†
43. **Ill.:** Chicago — Adler Planetarium, 1300 Lake Shore Dr. $1; child, 50¢.
44. **Kans.:** Hutchinson — Hutchinson Planetarium, 1300 N. Plum. Shows on weekends. $1; child, 50¢.
45. **Mo.:** St. Louis — McDonnell Planetarium, 5100 Clayton Rd. Closed Mon. Galleries free. Star show: $1.25; child, 75¢.
46. **Nebr.:** Lincoln — Ralph Mueller Planetarium, 14 & U Sts. 75¢; child, 35¢.
47. **Nev.:** Reno — Fleischmann Atmospherium-Planetarium, Hway 395. Closed Mon. $1.50; child, 75¢.
48. **N. Y.:** NYC — Hayden Planetarium, 81 St. & Central Park W. $1.75; child, 90¢.
49. **N. C.:** Chapel Hill — Morehead Planetarium, Univ. of N. C. Closed Dec. 24-25. $1.25; child, $1, 75¢.
50. **Pa.:** Pittsburgh — Allegheny Observatory, Riverview Park. Open April 1-Nov. 1.
50. **Pa.:** Pittsburgh — Buhl Planetarium, Allegheny Sq. Closed Christmas. $1.10; child, 50¢.
51. **Tex.:** Fort Davis — McDonald Observatory. Closed Christmas. Free.
52. **Utah:** Salt Lake City — Hansen Planetarium, 15 S. State St. Closed Mon. $1; child, 75¢, 50¢.
53. **W. Va.:** Green Bank — Natl. Radio Astronomy Observatory. Open daily Mid-June to Labor Day, weekends Sept. 8-Oct. 28.
54. **Wyo.:** Casper — Casper Planetarium, 10 Union Blvd. Closed weekends. Free.
55. **Alta:** Calgary — Centennial Planetarium, 6 Ave. & 11 St. S.W. Free.
56. **Alta:** Edmonton — Queen Elizabeth Planetarium, Coronation Park. Closed Mon. $1; child, 25¢.
57. **B. C.:** Pendicton — Dominion Radio Astrophysical Observatory. Open Sun. July & Aug. Free.
58. **B. C.:** Vancouver — MacMillan Planetarium, 1100 Chestnut St. Closed Mon. 50¢; child, 25¢ (shows extra).
59. **Ont.:** Toronto—McLaughlin Planetarium, 100 Queens Park. 50¢; child, free.

TECHNOLOGY

60. **Alaska:** Palmer — Matanuska Valley Museum, Wasilia St.*
61. **Ariz.:** Phoenix — Ariz. Mineral Museum 19 Ave. & McDowell. Closed state hols.
62. **Colo.:** Denver—Clock Manor, Bergen Pk.*
63. **Conn.:** Bristol — Amer. Clock and Watch Museum, 100 Maple St. Open Mar. 31-Nov. 1 (except Mon.). $1; child, 50¢.
64. **Conn.:** Kent — Sloane Stanley Museum, Rte. 7. Closed Mon., Tues. 50¢; 25¢.
65. **Conn.:** Terryville — Lock Museum of America, 114 Main St. Closed Mon.
66. **Del.:** Wilmington — Hagley Museum, Barley Mill Rd. & Brandywine Cr., Greenville. Closed Mon., Thanksgiving, Christmas, New Year. Free.
67. **Del.:** Yorklyn — Magic Age of Steam, Rte. 82. Open daily July, Aug.; weekends rest of year. $1; child, 50¢.
68. **Idaho:** Wallace — Coeur d'Alene District Mining Museum, 509 Bank. Closed Sun.
69. **Ill.:** Rockford — Time Museum, 7801 E. State St. Closed Mon., major hols. $1; child, 50¢.
70. **Iowa:** Mt. Pleasant—Midwest Old Settlers and Threshers Heritage Museum, Rte. 4. Open May 27-Sept. 4. $1 (reunion, $2).
71. **Iowa:** Spillville — Billy Clock Exhibit, Dvorak House. Open Apr. 30-Nov. 1. $1; child, 35¢.
72. **Kans.:** Hill City — Oil Museum, 811 N. Main St., Free.
73. **Maine:** Patten — Lumbermen's Museum, Rte. 195. Open May 26-Oct. 15, except Mon. Donation.
74. **Maine:** Poland Spring — Shaker Museum, Rte. 26. Open May 29-Oct. 1, except Sun. $1.50; child, 75¢.
75. **Md.:** Baltimore — Mt. Vernon Museum of Incandescent Lighting, 717 Wash. Pl.†
76. **Mass.:** Sturbridge — Old Sturbridge Village. Closed Christmas, and New Year. $3.50; child, $1.25.
77. **Minn.:** Chisholm—Minn. Museum of Mining. Open May 26-Sept. 9. $1, child, 50¢.
78. **Miss.:** Vicksburg — U.S. Army Engineers Waterways Exp. Station, 3909 Halls Ferry Rd. Closed Sat., Sun., natl. hols. Free.
79. **Mo.:** Joplin — Tri-State Mineral Museum, Schifferdecker Pk. Closed Mon. Free.
80. **Mont.:** Butte — World Museum of Mining, W. Park St. Jun. 9-Sept. 16, except Mon.
81. **Mont.:** Great Falls — Mehmke's Steam Museum, Highwood Star Rte. 50¢.
82. **Mont.:** Missoula — Northern Forest Fire Lab.,Intermtn. Forest & Range Exp. Sta., Closed Sat., Sun. Free.
83. **Nebr.:** Grand Island — Stuhr Museum of Prairie Pioneer. Free.*
84. **N. H.:** Newport — Clock Museum, Common. 95¢; child, 50¢.
85. **N. J.:** Ft. Monmouth — U.S. Army Signal Corp Museum, Myer Hall. Free.
86. **N. J.:** Newark — Pioneer Historical (telephony) Museum (moving — write H. G. McCully, c/o N. J. Bell Telephone Co., 540 Broad St., Newark, N. J. 07101.)
87. **N. J.:** New Brunswick — DeLaplaine Collection Electrical Museum, 125 Georges.†
88. **N. J.:** West Orange — Edison Natl. Historic Site, Main St. & Lakeside Ave. Closed Thanksgiving, Christmas, New Year. 50¢.
89. **N. Y.:** Corning — Corning Glass Center.*
90. **N. Y.:** Monroe—Old Museum Village, Rte. 17M. Open Apr. 14-Nov. 1. $2; child, $1.
91. **N. Y.:** NYC — Museum of Genl. Soc. of Mechanics & Tradesmen, 20 W. 44 St.
92. **N. Y.:** North Creek — Garnet Mine Display, Barton Mine Corp., end of Gore Mountain Rd. Open last week in June to Labor Day. $1; child, 50¢.
93. **N. Y.:** S. Ostelic — Gladding Intl. Sport Fishing Museum. Open Apr. 30-Oct. 2.
94. **Ohio:** Mount Vernon — Old Tool Crib Museum, Rte. 13.*
95. **Ore.:** Klamath Falls — Logging Museum, Collier State Park. Free.
96. **R. I.:** Pawtucket — Old Slater Mill Museum, Roosevelt Ave. Closed Mon., Natl. hols. Jan. $1; child, 50¢.
97. **S. D.:** Custer — Black Hills Museum of Mining and Minerals, 624 Crook St.*
98. **Tex.:** Alamo — Live Steam Museum, 1¾ mi. N on FM 907. Closed hols. Donation.
99. **Tex.:** Cresson — Hal Smith Farm Machinery Museum, Hway 377. Donation.

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that offer great stopovers for vacationing readers

100. **Tex.:** San Angelo — E. H. Danner Museum of Telephony, 2701 S. Johnson St. Closed Sat., Sun. Free.
101. **Vt.:** Bellows Falls — Steamtown Foundation, Rte 5. $3.95; child, $2.50.*
102. **Vt.:** Shelburne — Shelburne Museum. May 15-Oct. 15. 3.50; child, $1.50.
103. **Vt.:** Windsor — American Precision Museum. July 1-Oct. 31. $1; child, 75¢.
104. **B. C.:** Ft. Langley — B. C. Farm Machinery Museum.*
105. **N. S.:** Baddeck — A. G. Bell Natl. Historic Park, Box 159. Open Apr. 1-Nov. 30, except hols. Free.
106. **Ont.:** Brantford — Bell Homestead, Tutela Heights Rd.*
107. **Ont.:** Elliott Lake — Nuclear and Mining Museum, Hwy. 108.*
108. **Ont.:** Kingston — Pump House Steam Museum, 23 Ontario St. Open June 4-Sept. 15. $1 family membership fee.
109. **Ont.:** Kirkland — Museum of Northern History, 20 Duncan Ave.*
110. **Ont.:** Oil Springs — Oil Museum of Canada. Open May 15-Oct. 15. 75¢; child, 35¢, 25¢.
111. **Sask.:** Regina — Telorama, 2350 Albert St. Closed Christmas. Free.
112. **Sask.:** Saskatoon—Western Development Museum. $1; child, 50¢, 25¢.

WEAPONRY

113. **Ark.:** Berryville — Saunders Museum. Open Mar. 15-Nov. 15. 75¢; child, 25¢.
114. **Ark.:** Eureka Springs — Miles Mountain Museum, Hwy. 62. Open Apr. 1-Oct. 31. $1.50; child, 50¢.
115. **Ark.:** Rogers — Daisy Intnat'l. Airgun Museum, Hwy. 71 South. Closed Sat., Sun., hols. Free.
116. **Conn.:** Hartford — Conn. State Library Museum (Colt Firearm Collection), 231 Capitol Ave. Closed Sat. aft., Sun., hols.
117. **Conn.:** New Haven — Winchester Gun Museum, 275 Winchester Ave. Closed Sun., hols.*
118. **D. C.:** Washington — Natl. Rifle Assn. Firearms Museum, 1600 Rhode Island Ave., N.W. Closed Easter, Christmas, New Year. Free.
119. **Fla.:** N. Miami — Holbrook Arms Museum, 12953 Biscayne Blvd. Closed Sun., Mon. $1.
120. **Ill.:** Rock Island Arsenal — John M. Browning Memorial Museum. Closed Mon., Tues. Free.
121. **Ky.:** Ft. Knox — Patton Museum of Cavalry and Armor. Closed Christmas, New Year. Free.
122. **Mass.:** Springfield — Springfield Armory Museum, Federal St. $1.
123. **Mo.:** Jefferson City — Missouri State Museum, State Capitol Bldg. Closed Christmas. Free.
124. **N. Y.:** Ilion — Remington Gun Museum, Hoefler Ave. Free.
125. **Okla.:** Claremore — J. M. David Gun Museum, 333 N. Lynn Riggs Blvd. Closed Christmas. Free.
126. **Pa.:** Intercourse — Pa. Rifle Museum, Rte. 340. Closed Mon., Sept. 1-June 1. $1; child, 50¢.
127. **Utah:** Ogden — John M. Browning Museum, 5100 S. Washington Blvd.*
128. **Wisc.:** Milwaukee — Milwaukee Public Museum, 800 W. Wells St. Closed major hols. $1; child, 25¢.

TRANSPORTATION

129. **Ariz.:** Scottsdale — Hall of Flame, 3626 Civic Center Pl. $1; child, 35¢.
130. **Ark.:** Morrilton — The Museum of Automobiles, Petit Jean Mountain. $1.50; child, 75¢.
131. **Calif.:** Bishop — Bishop R. R. Museum, 324 Grove St. Closed Thanksgiving, Christmas, New Year. Donation.
132. **Calif.:** Costa Mesa — Briggs Cunningham Automotive Museum, 250 E. Baker St. Closed Mon., Tues. Men $2, women $1.50; child, 50¢.
133. **Colo.:** Colorado Springs — El Pomar Carriage House Museum, Lake Ave. Closed Mon. Free.
134. **Colo.:** Denver — Veteran Car Museum, 2030 S. Cherokee St. Closed Sat. aft., Sun. Free.
134. **Colo.:** Denver — Forney Transportation Museum, 1416 Platte St. Closed Christmas. $1.50; child, 70¢, 30¢.
135. **Colo.:** Golden — Colo. Railroad Museum, 17155 W. 44 Ave. Closed Christmas. 90¢; child, 35¢.
136. **Colo.:** Manitou Springs — Colo. Car Museum, Hwy. 24W & Hwy. 24Bus. Weekends only Oct. 15-May 1. $1; child, 35¢.
137. **Conn.:** E. Haven — Branford Trolley Museum, 17 River St.*
138. **Conn.:** Manchester — Antique Auto Museum, Slater St. Closed weekends Sept.-June. 99¢; child, 50¢.
139. **Conn.:** Warehouse Point — Conn. Electric Railway Assn., Rte. 140. Closed Christmas. 75¢; child, 50¢.
140. **Fla.:** Daytona — Mus. of Speed, U.S. 1.*
141. **Fla.:** Ft. Lauderdale — Gold Coast RR, 811 S.W. 34 St. Closed Sun. $2; $1.

142. **Fla.:** Sarasota — Bellm's Cars of Yesterday, 5500 N. Tamiami Trail. $2.34; child, $1.
143. **Ga.:** Hamilton — Hamilton on the Square Antique Auto Museum, $1; child, 75¢.
144. **Ga.:** Stone Mountain — Antique Auto Museum. $1; child, 50¢.
145. **Ill.:** Petersburg — New Salem Carriage Museum, Rte. 97 So. Open May 1-Nov. 1. 80¢; child, 40¢.
146. **Ill.:** Union — Ill. Railway Museum, Olson Rd. Jun.-Sept., daily; May, Sept., Oct., weekends. Free.
147. **Ind.:** Elkhart — Hubbard Hill Museum, Rte. 19.*
148. **Ind.:** Kokomo—Elwood Haynes Museum, 1915 S. Webster St. Closed Mon. Free.
149. **Ind.:** Terre Haute — Early Wheels Museum, 817 Wabash Ave. Closed Sat., Sun., hols. Free.
150. **Kans.:** Ashland — Santa Fe Museum.*
151. **Kans.:** Hesston — King's Antique Car Museum, Hwy. 81. Closed Mon. $1; child, 50¢.
152. **Ky.:** Louisville — Kentucky Railway Museum, Upper River Rd.*
153. **Maine:** Bar Harbor — Seal Cove Automobile Museum.*
154. **Maine:** Boothbay — Boothbay Railway Museum, Rte. 27. Summer, open daily; spring & fall, weekends. 75¢; child, 50¢.
155. **Maine:** Kennebunkport — Seashore Trolley Museum, Log Cabin Rd. Open Apr. 1-Oct. 31. Free.
156. **Md.:** Baltimore — B&O Transp. Museum, Pratt & Poppleton Sts. Closed Mon., Tues. $1; child, 50¢.
157. **Mass.:** Brookline — Museum of Transportation, 15 Newton St. Closed Mon. $1.50; child, 75¢, 25¢.
158. **Mass.:** Sandwich — Heritage Plantation, Grove St. May 1-Oct. 15. $2; 75¢.
159. **Mass.:** Sturbridge — Sturbridge Auto Museum, Rte. 20. Open Apr. 1-Nov. 30. $1; child, 50¢.

[Continued on page 152]

SPECIAL OFFER TO POPULAR SCIENCE READERS

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CANOE CAMPING

—rich adventure on a budget

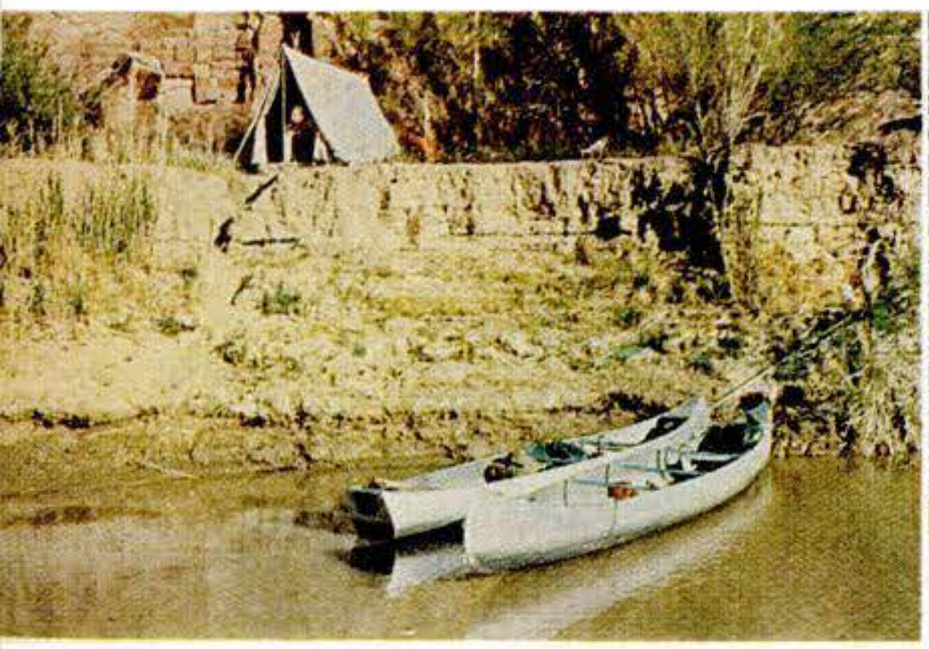
Rivers aplenty—plus modern equipment. Daniel Boone never had it so good

By RAY HILL
PHOTOS: BY JOHN FLANNERY AND AUTHOR

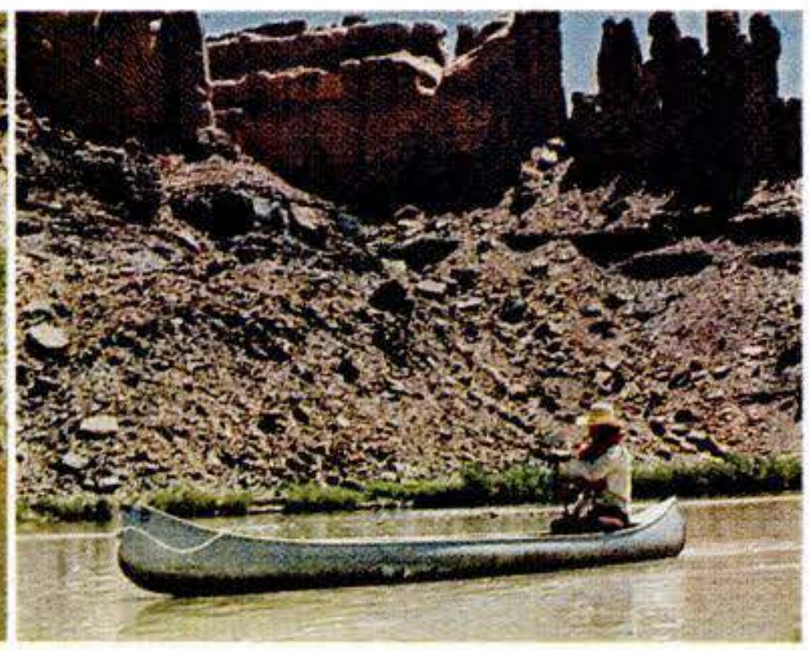
Life jackets should always be worn, even when exploring the small streams.

We put our canoes into the water at the little town of Green River, Utah. For the next five days, we paddled and floated 130 miles down the Green River to the mighty Colorado, explored old settlers' cabins, Indian ruins, and historic outlaw hideouts. We ate lunch beside an erupting geyser, slept in tents, cooked our meals over wood fires and a small portable stove.

And we absorbed the magnificent scenery—the river itself, the rugged, mountainous landscape, the ever-changing desert through which the river winds. During the whole time we didn't see anyone other than the four members of our party. We felt civilization slipping away, and ourselves growing a little closer to the Earth.



A steep bank prevented Hill's party from carrying canoes ashore one night, so they tied them to trees at water's edge.

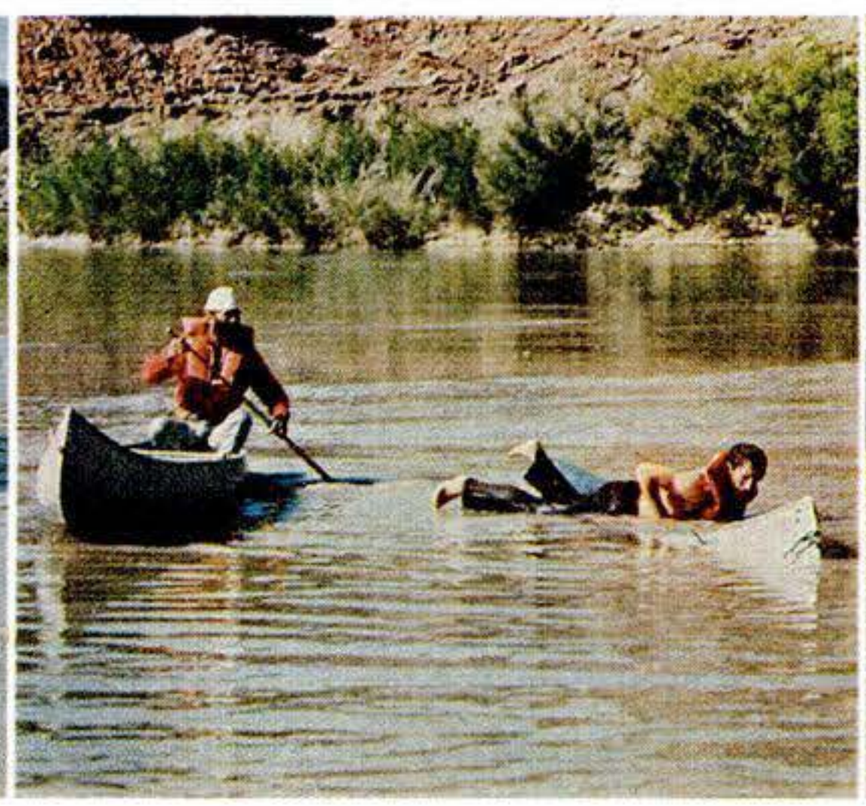


For easier handling when paddling alone, your canoe should be loaded so the bow floats slightly above stern.

The canoe is a very stable craft and can be tilted considerably before it will capsize, as author demonstrates here.

You can get back in a water-filled canoe. Trick is to position body so weight is equal over gunwales—and climb in.

A cooking pot can be used to bail out canoe. Or you can paddle water-filled craft (right) to shore and empty it.



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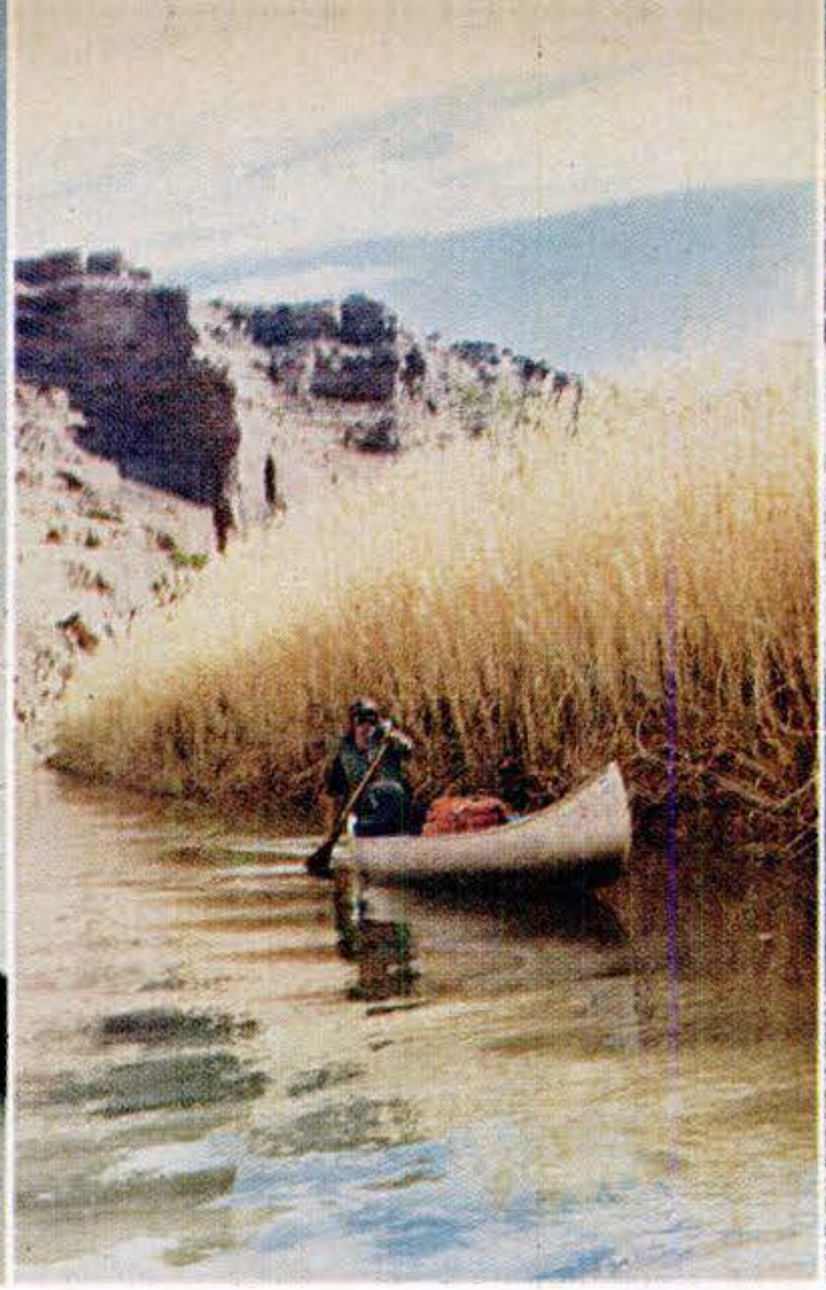
To get into canoe safely, grasp both gunwales, put one foot in the boat near the centerline, and lift other foot in.



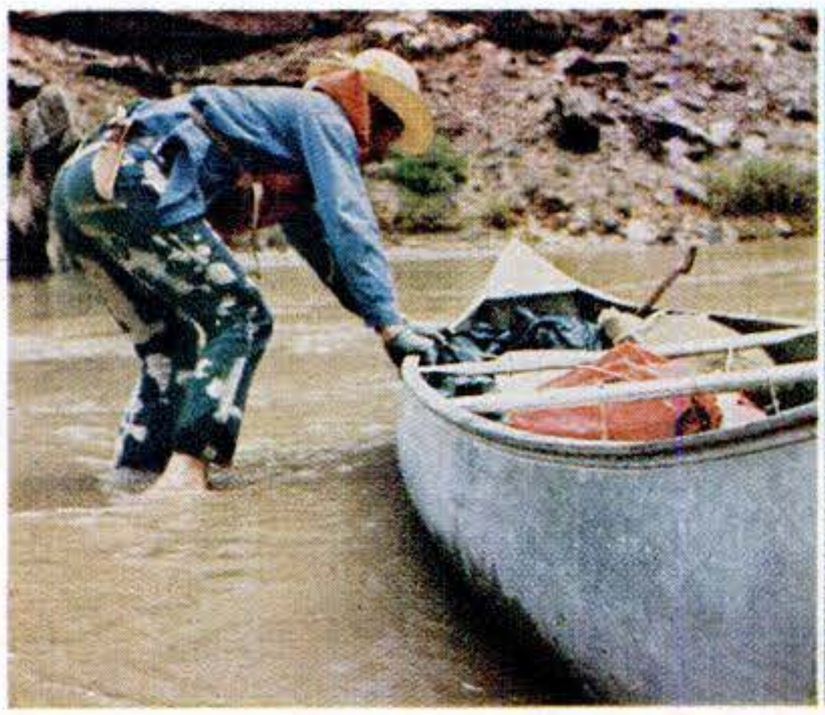
Current flow can be stronger close to shore when the river is low—making downstream travel quicker there.

Hill fills his canoe with driftwood for campfire. His party camped farther downstream where there was no wood.

You can do it, too. In fact, it's the kind of adventure you can expect when you go canoe camping. There are thousands of scenic rivers and lakes all over the U.S. and Canada, many within easy driving distance of where you live. You can find out about them from your state's Parks, Recreation and Travel Commission Office and the Canadian Travel Bureau in Ottawa, and you don't have to be an expert at camping—or canoeing.

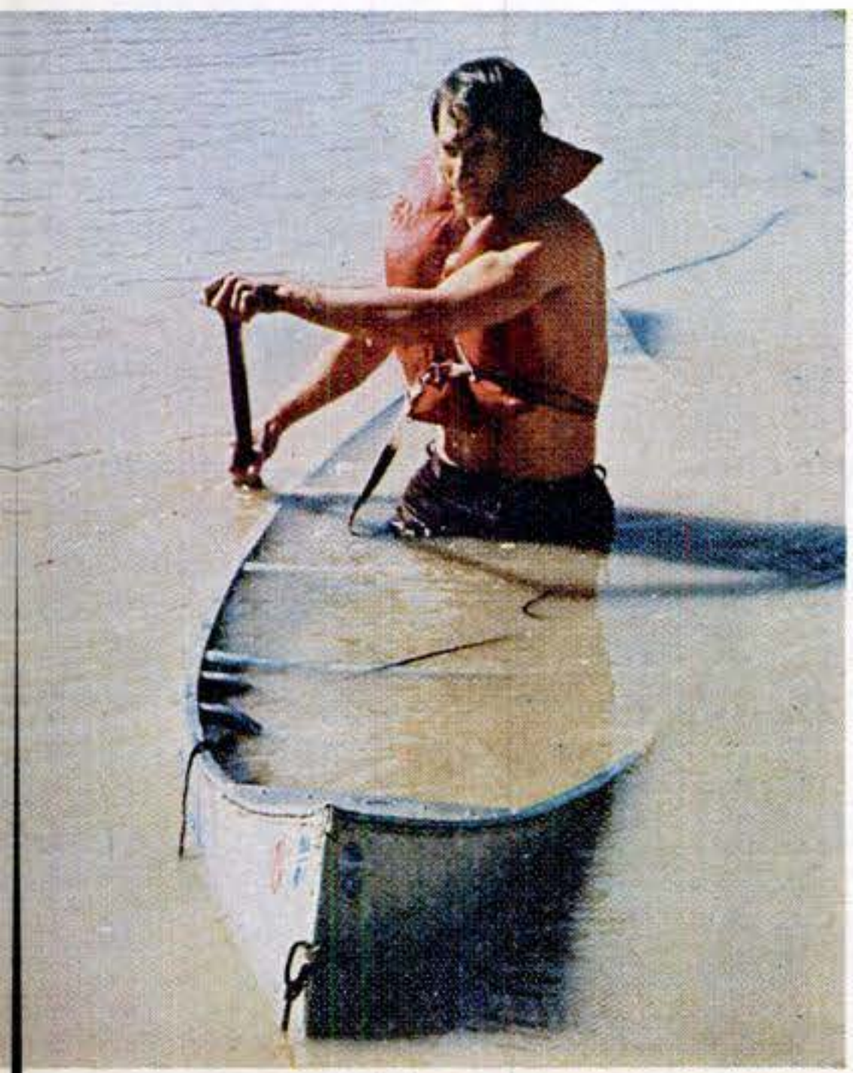
Getting started. If you're a backpacker, you probably have most of the gear you need already—except the canoe. If you're not a backpacker

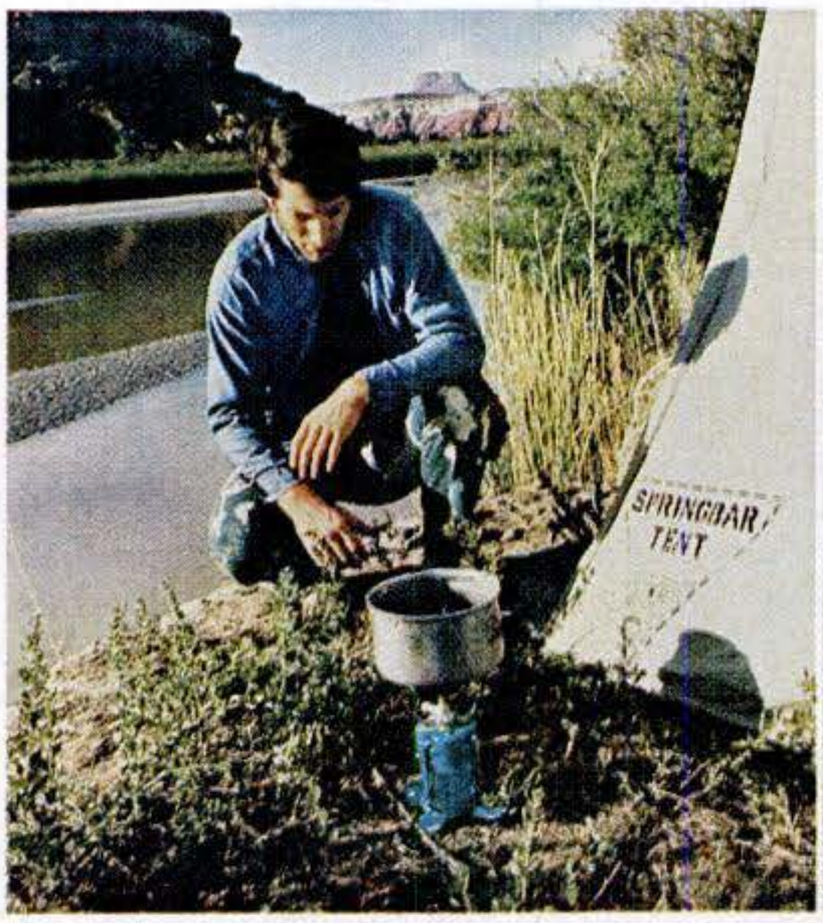
[Continued on page 148]



If you run aground and can't push off with your paddle, get out and shove. Wear your lifejacket, grasp canoe firmly.

To eat lunch together on the water you can lash canoes together and drift—if the water's calm and there are no rapids.





Boiling is a must if you're going to drink river water. Even though it may look clean, it can be contaminated.

This is one of the reasons why you should boil it. Hill's group passed this dead animal in the water on fourth day.

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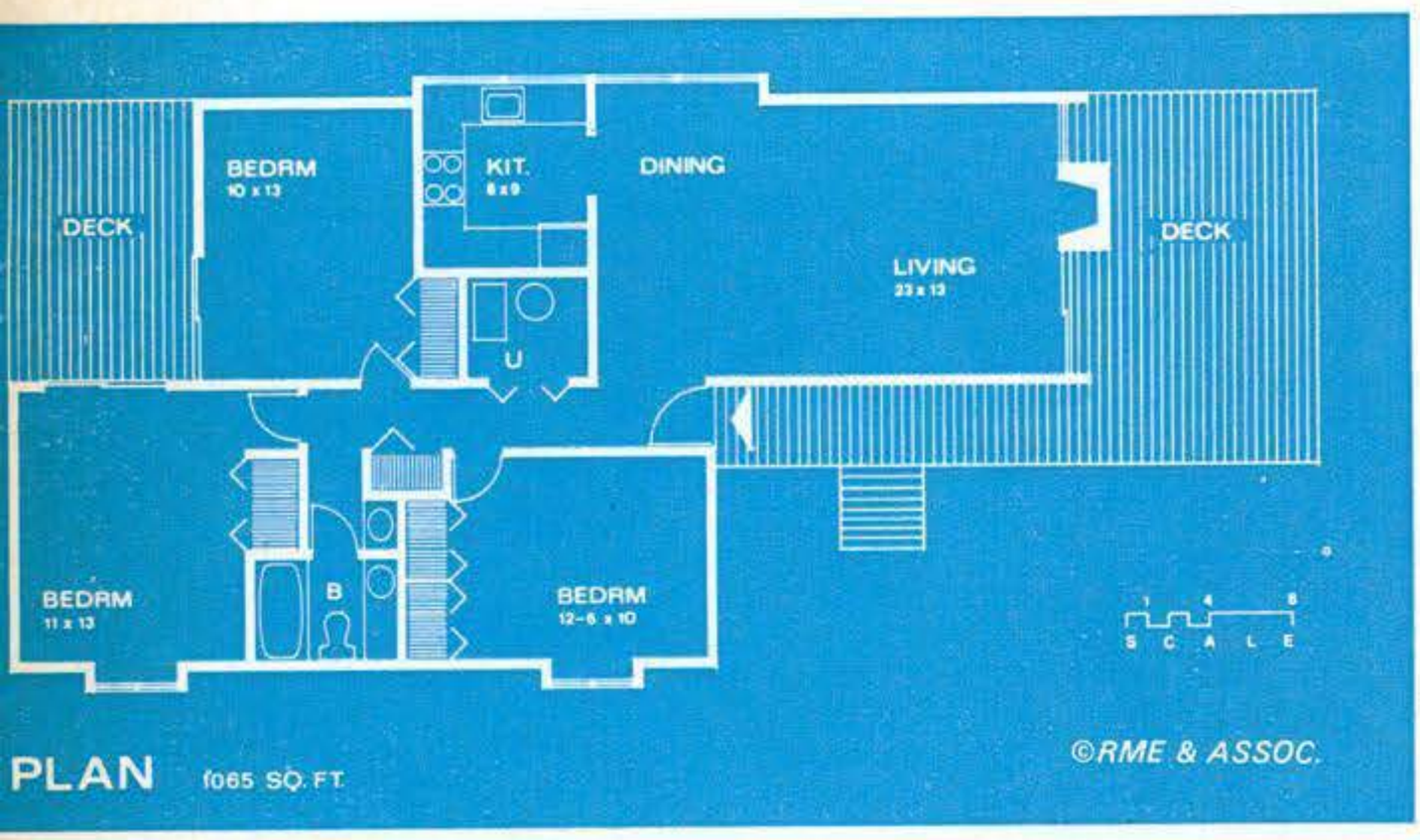
PS **LEISURE HOME Plan of the Month**

Split Gable Offsets for Privacy



Architect Robert Martin Engelbrecht calls this the Lenape. It's third in our plans series with the V-PAC Council

Shrewdly zoned for vacation guests, this house is sliced down its ridgeboard and the halves offset to create a protected deck at front and rear. That third bedroom (at back) could be omitted if you'd prefer a larger deck area adjacent to the kitchen, with a rear entry behind the utility room.

The zoned plan lets this compact house perform as a much larger structure. The front hall gives quick access to all active areas with no traffic bottlenecks. The bath includes an extra lavatory for double efficiency. The inevitable mud, sand or snow track-in is minimized by the protected entry. The back bedrooms, removed from the bustle, share a deck through patio doors. Similar doors, up front, expand the living room right past the fireplace chase to encompass the larger deck.

Windows are placed to offer views in all directions, yet maintain privacy and adequate wall space for furniture. Sloping ceilings follow roof lines to give an airy, open feeling.—*Al Lees*

You can order plans several ways

Lenape study plan ($1) is spec sheet with additional information to help you decide if house fits your needs and site. V-PAC Guide ($2) is catalog of all plans in series, plus building tips. One set of blueprints, $25; three sets, $35. Remit to PS Vacation Plans Service, Box 622, Princeton, N.J. 08540.

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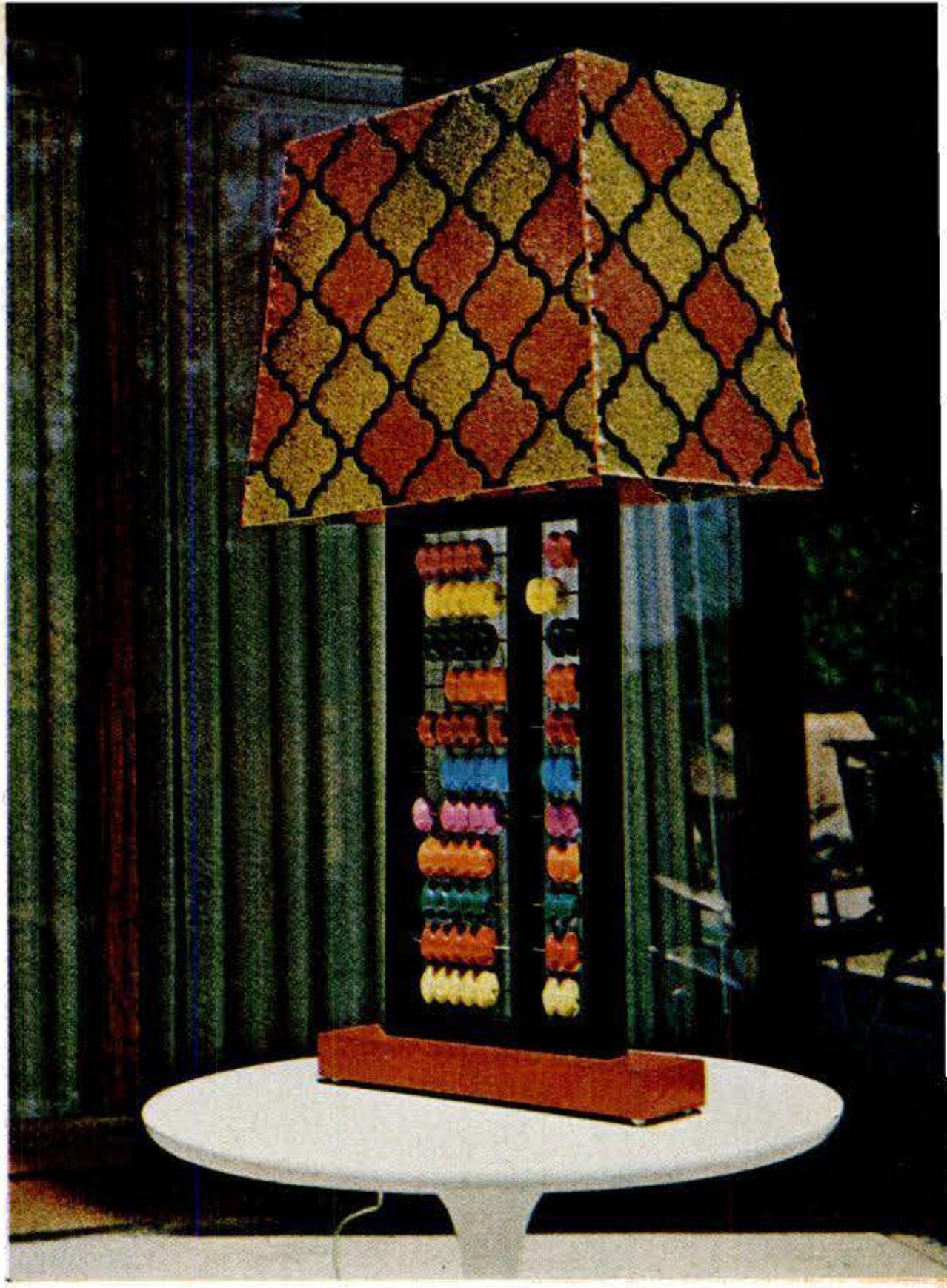
ABACUS LAMP

The original calculator—dressed in mod colors—makes a novel base for a table lamp . . . it's an easy weekend project

By HAL and BARB SCHELL
DRAWING BY HANK TOMKALSKI



Those portable calculators you've been hearing so much about aren't a new concept—the ancients toted an abacus with them for similar purposes. True, these weren't electronic—but lightning computations could be made by flicking counters along rods in a frame.

Since the abacus has shed light on many problems over the ages, we deemed it an appropriate lamp base—and set out to design a doubly functional unit. The result is as colorful a lamp as you'll ever make. And kids never tire of playing with the movable counters, creating ever-new color patterns.

We found our counters at a bead shop, already drilled for stringing. They're 1¼"-dia. wood disks. We made another lamp using cork floats of a similar diameter, but their ball shape required a wider frame; we prefer the proportions possible with the flatter beads.

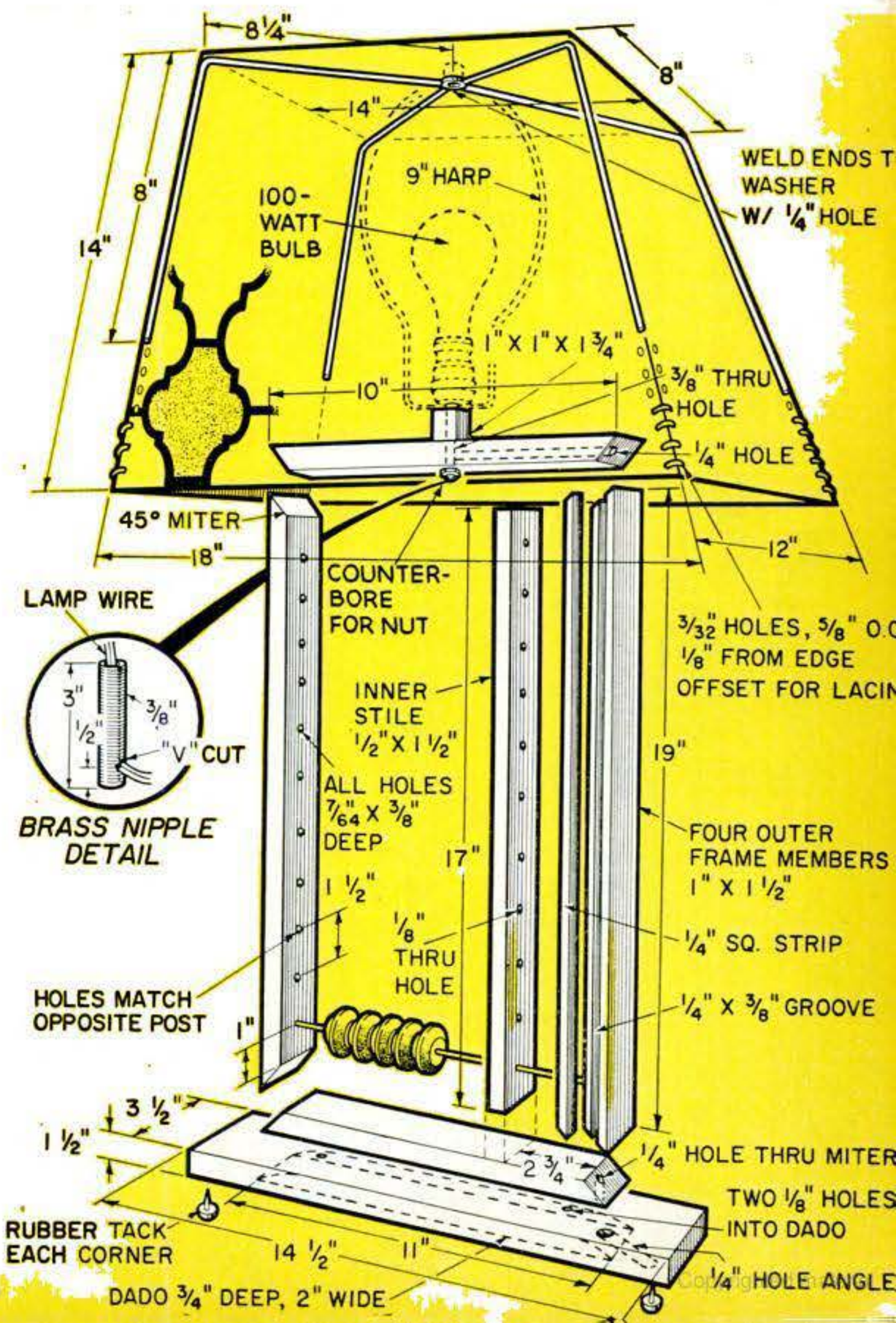
For the counter rods, we used bicycle spokes, but 3/16" coat-hanger wire would do as well. You need eleven 8 5/16" lengths to duplicate our design, and there are seven counters on each—five on one side of the stile, two on the other. This is the authentic abacus you may have seen Chinese laundrymen use. They'd start a computation with all counters pushed to the outside; each righthand counter has a value of five.

Construction and assembly are simple. Note how the wiring is concealed within the wood frame. One vertical member is grooved (on table saw or with router) about ⅜" deep. The lamp wire is pressed to the bottom of this groove; a matching strip of wood is glued on top, flush with the surface of the frame (or drill a ¼" hole through the full length of this frame strip before mitering the ends.) The wire is then fed through a slot hacksawed in the side of the brass nipple.

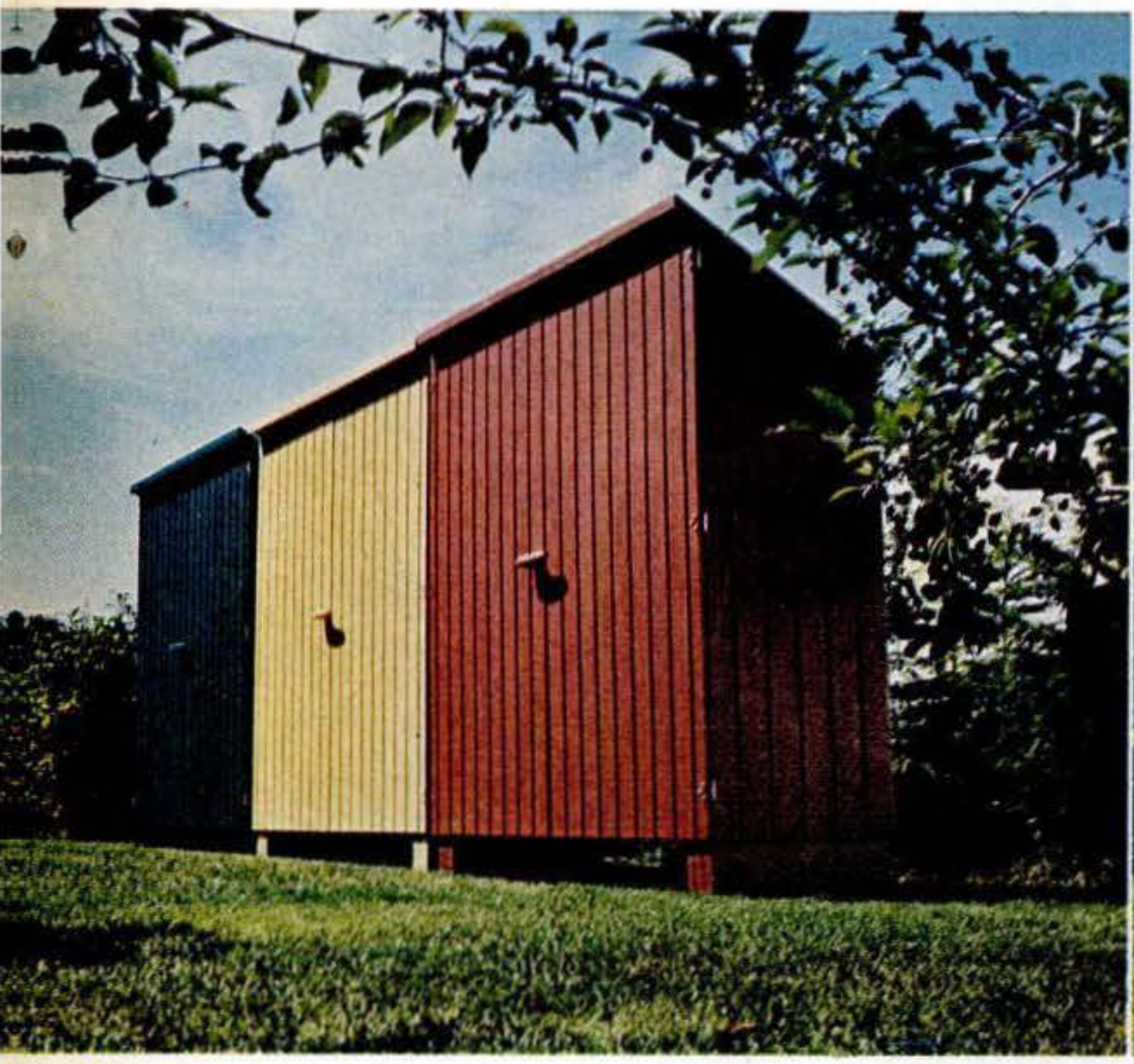
After painting the counters a variety of bright colors, "string" five of them on each rod, slip the rod through the center stile, add two more disks, then poke each end of the rod into a snug hole in the frame members; secure each with a dab of epoxy when assembly is complete. You glue and nail the mitered corners just as you would a picture frame.

To keep the unit slim yet stable, we scooped out the underside of the base by moving the block over a tablesaw blade projecting ¾". Drill two clearance holes into this dadoed area; glue and screw the abacus to the base with 1¼" screws driven up through the dado. Randomly turn a half-dozen 1" screws into the dado area, letting them protrude ½". Melt five pounds of lead and fill the recess flush.

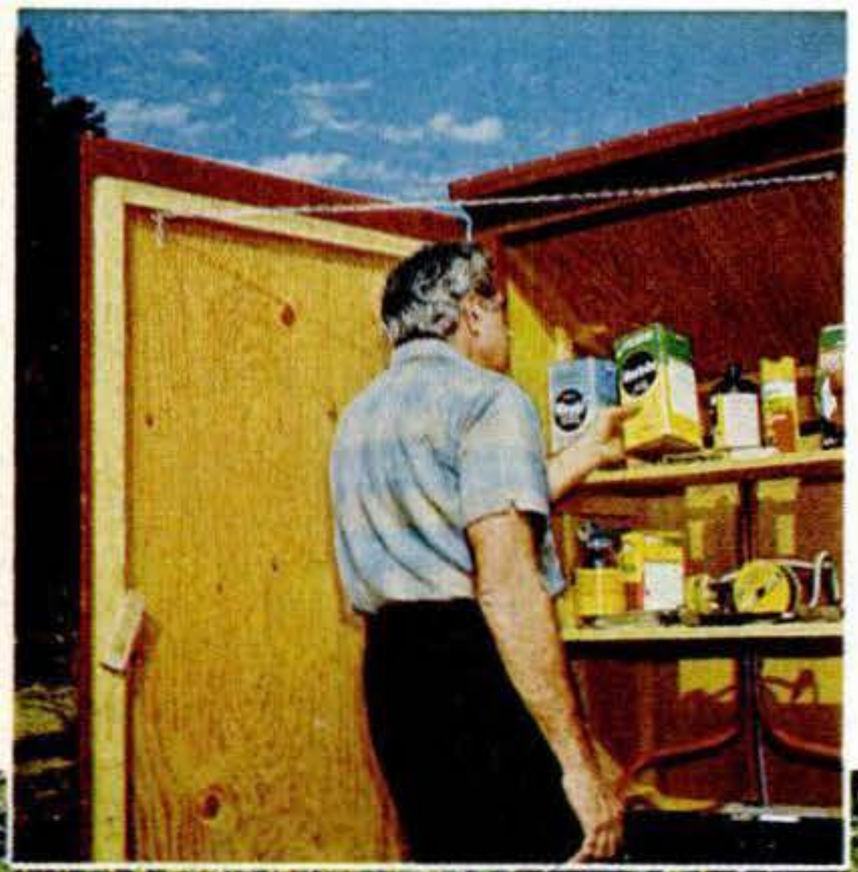
We made our own shade from 1/16" plastic panels assembled with flat lace and coat-hanger wire. PS

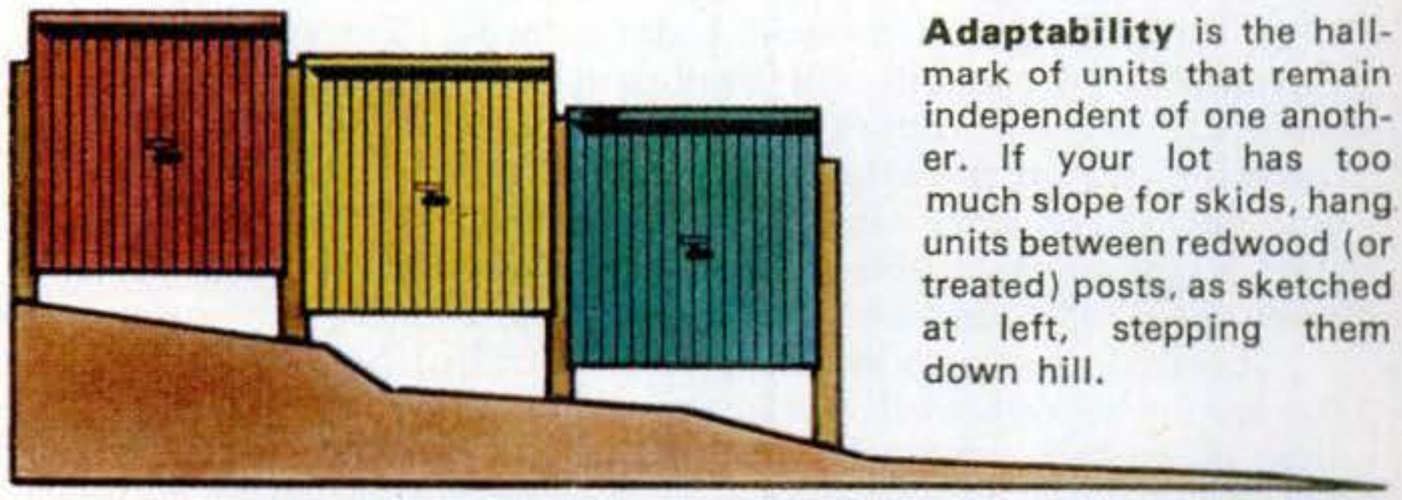


STORAGE WALL Doubles



Line 'em up at edge of your yard (left) to block an eyesore or create a friendly visual barrier along your neighbor's patio. You saw these units, last month, in the background of our Barbecue Deck. If your privacy problem's at a corner, set units at right angles (above). Where ground is perfectly flat, they sit on skids of 6-by-6s or railroad ties.





Adaptability is the hallmark of units that remain independent of one another. If your lot has too much slope for skids, hang units between redwood (or treated) posts, as sketched at left, stepping them down hill.

as Privacy Fence

Customize two or three units to serve your needs for outdoor storage and lot-line screening

By ROSARIO CAPOTOSTO / From a design by Jeffrey Milstein
PHOTOS BY THE AUTHOR/DRAWINGS BY CARL DeGROOTE

Attractive as these units are, the thing that truly recommends them for your bulky outdoor storage is their adaptable *function*. The modular concept lets you make as many units as required to store present items and create a visual boundary for your yard. If, in time, you need more units for either use, you just add one or two, stained to match.

You needn't even line up the units if a privacy fence or windbreak isn't what you want. Each unit is free-standing and could be strategically located near the activity area it serves: a shed for large tools beside the garden . . . storage for folded furniture at patio's edge . . . chemicals and sports gear by the pool, as a few examples. Materials for the three shown cost under $350.

Framing is 2-by-2 stock, with 1-by-2s added as nailers for siding joints, and to act as shelf cleats. Framing can be simplified, if you're in a hurry, since the 5/8" plywood skin—intended for application over house-framing without any sheathing beneath—stiffens the structure as it's applied. Our framing permits eco-

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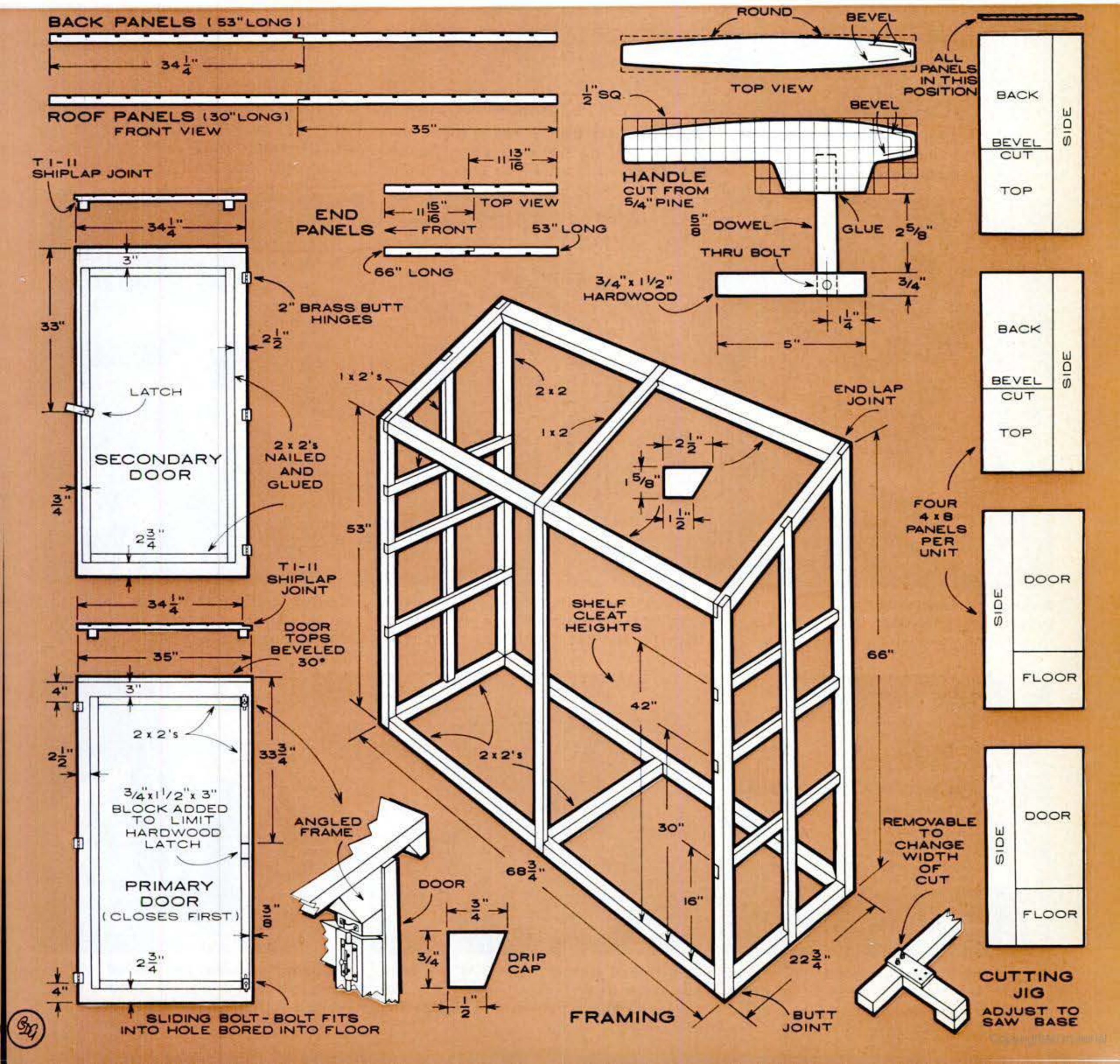


nomical cutting of siding from 4-by-8 sheets, as shown below. But if you cut one-piece end panels, for instance, omit the vertical 1-by-2s.

For our siding, we chose fir Texture 1-11 with 4″-o.c. grooving. A preservative stain is all the finish plywood siding requires. The only trick in cutting and applying these panels is to keep the grooving uniform for appearance. The long edges of each T1-11 panel are shiplapped to provide weathertight siding joints and to insure pattern continuity. If you section panels as shown on the sketches, mating joints result.

Basic framing is identical for both shelf and Peg-Board-lined versions, but there are differences in cleats and nailing strips.

For quick, accurate assembly, make the simple nailing jig shown in photo; lay a piece of wax paper below each joint to keep ooze-out glue from bonding to the worktable.

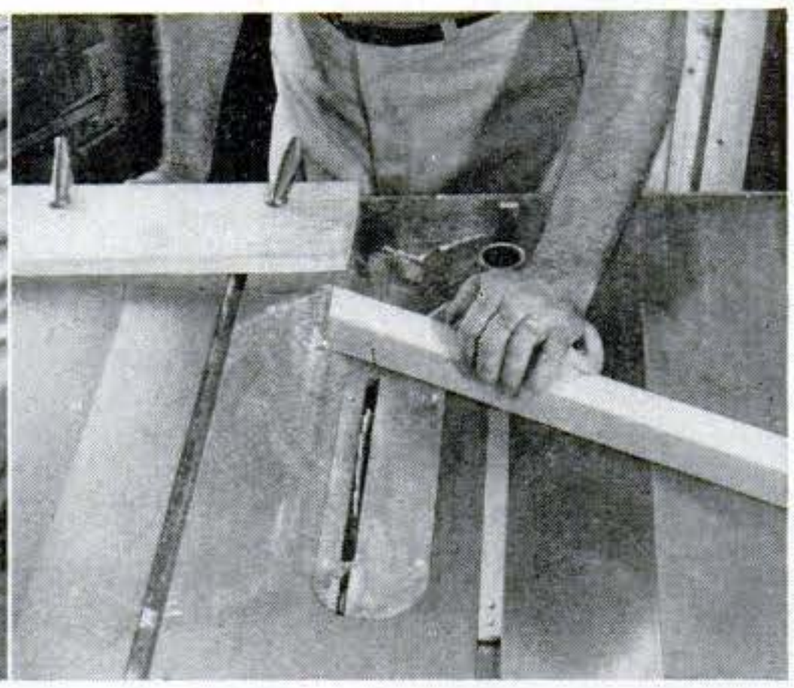
Angled cross pieces for the roof frame are cut from 2-by-3s. Cut 3/8″ dadoes to "half-lap" the center nailing strips. Once a frame is assembled, set it level and check for squareness before glue sets; tack on temporary diagonal braces to true up, if necessary. Brush a liberal coat of wood preservative (such as Woodlife) on all frame members before applying siding. If you use annular-ringed galvanized nails spaced 6″ to 8″, you can assemble without glue. Drive nails through lap joints at an angle to catch both edges.

After sawing off the first side pair, as shown in sketches, cut across what remains of the panel with your saw at 30 degrees to separate back and top pairs. One cut gives you both edge-bevels; but the paired backs will be too wide. Just center on frame and trim both edges.

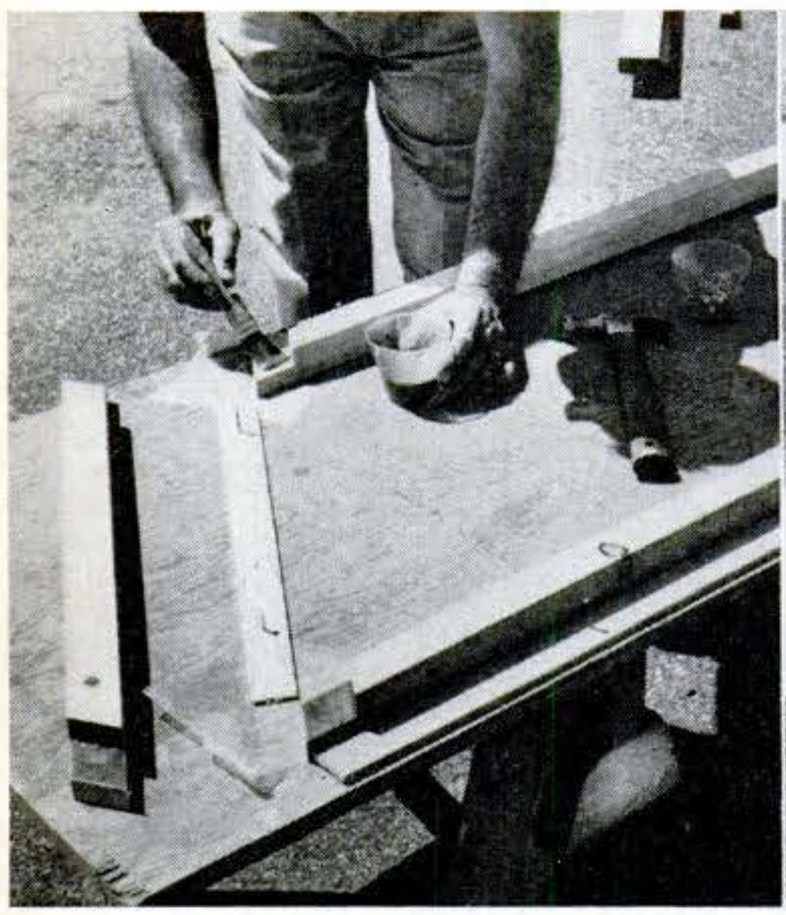
For each 6-by-6 skid we face-nailed three redwood 2-by-6s. Wolmanized lumber would do as well.

Mount hinges flush on door backs with FH bolts and nuts. Then rout or chisel matching gains in the frame to accept both leaf thicknesses. PS

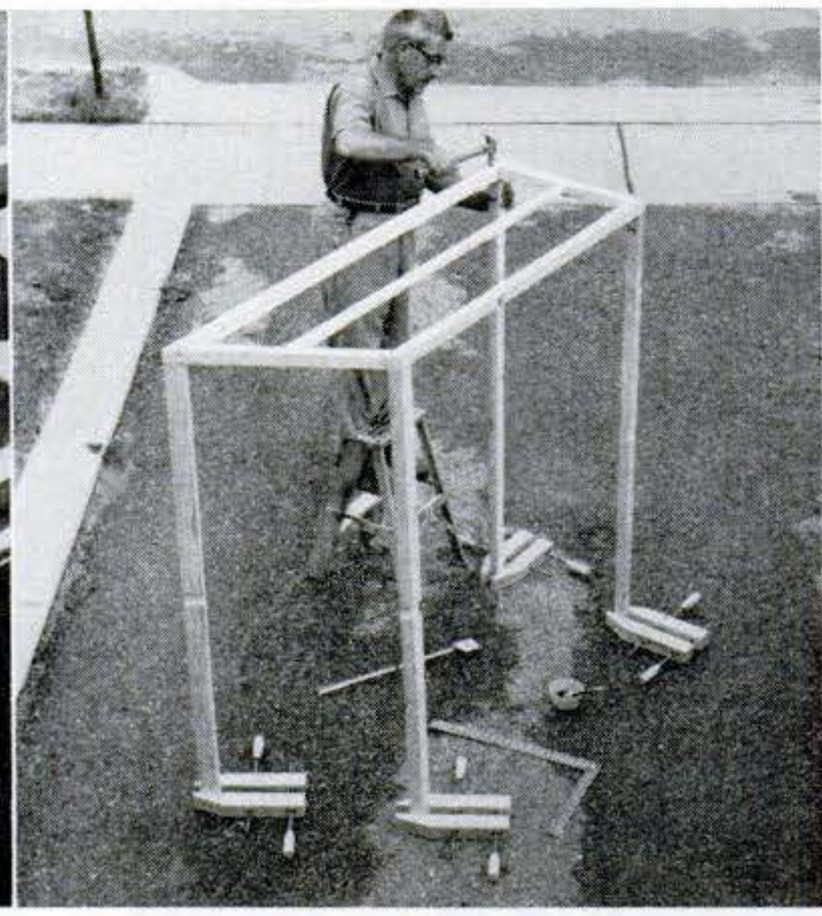
Cut all frame members to length, ends beveled where needed. Set rails on stiles, knife-mark for end-lap joints.



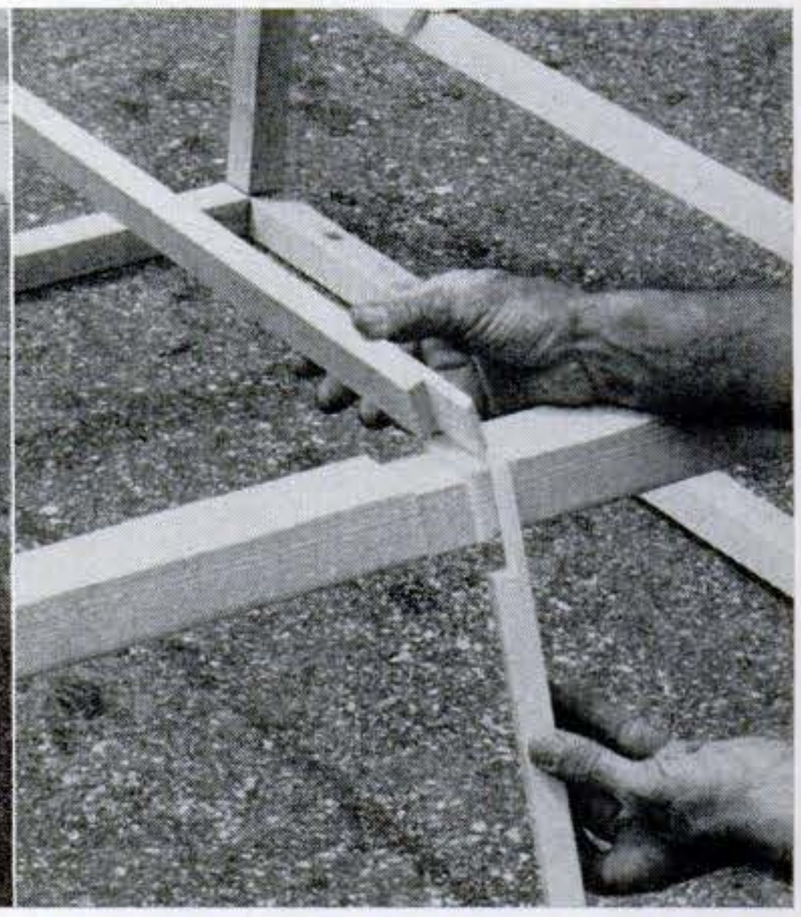
Cut shoulder kerf on knife mark, then switch to dado blade to complete rabbet. Clamped block keeps cuts uniform.



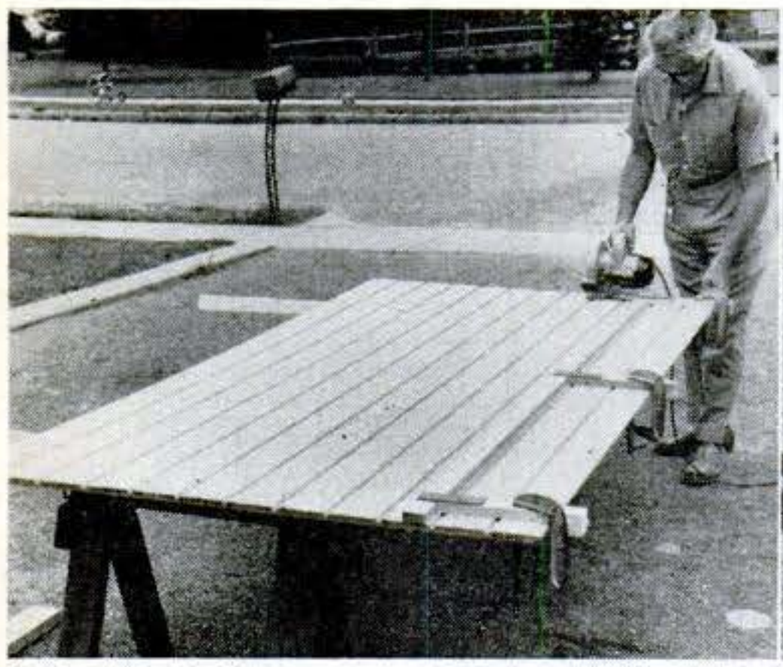
Assemble frame with waterproof glue (like resorcinol). Use jig of lath tacked to plywood to position frame parts.



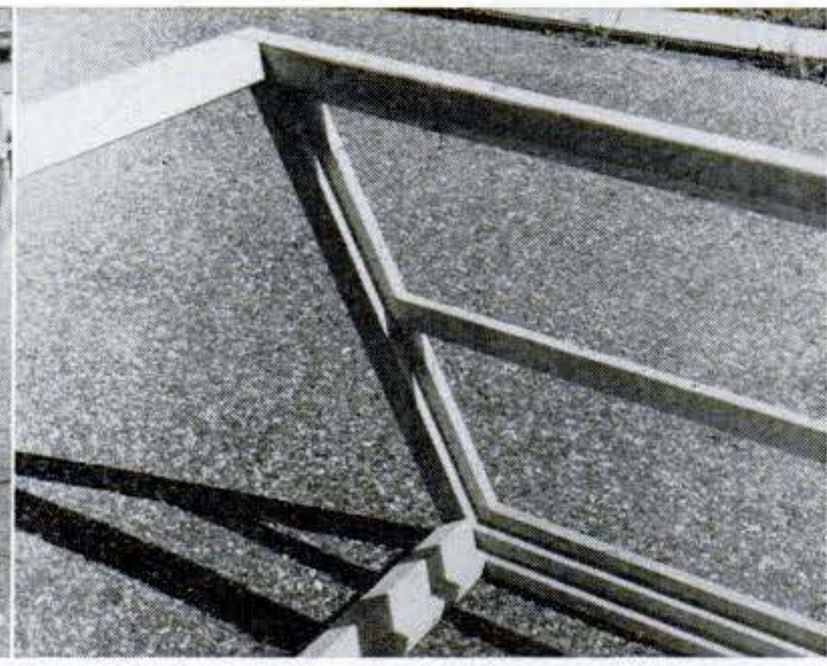
Galvanized nails—four per corner—complete assembly. Frame is removed from jig and set on clamp-held rails.



Center nailing strips are rabbeted to set into shallow dadoes. On side frame, similar strips set in full thickness.



Each 4-by-8 panel, ripped full length, supplies a side section—but jig depth differs for right or left cuts (see plan).



Peg-Board lining needs 3/4″-sq. back-up strips nailed along rear and side frames to attach panels, provide spacing.

Pivoting handle has dowel glued in front block only. Latch block, rear, is pegged with machine bolt through dowel.

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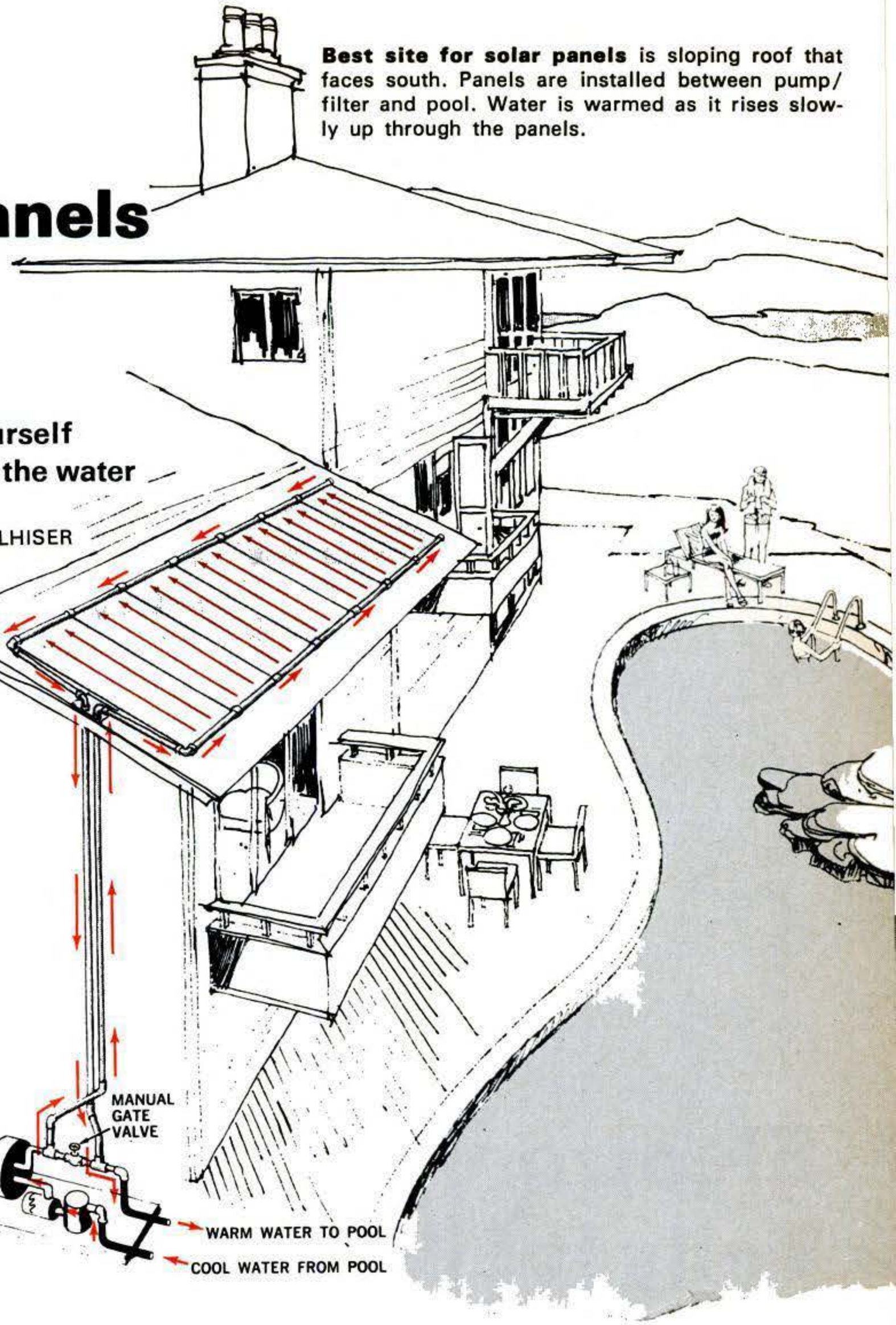
Pool-Heating Panels Make the Sun Work for You

No gas costs—with this install-it-yourself solar-heating system, nature warms the water

By TOM BOYD DRAWING BY HARVEY WOOLHISER



Best site for solar panels is sloping roof that faces south. Panels are installed between pump/filter and pool. Water is warmed as it rises slowly up through the panels.

Installation of 30-pound panel sections requires only one person. Brackets prevent movement by wind.

Black plastic absorbs solar energy even on overcast days. Coarse extrusions provide maximum exposure for water.

Does cool water dampen the enjoyment of your pool? A water heater is the obvious answer. When Californian Freeman Ford looked at the seasonal $150 gas bill for conventional heaters, however, he said no thanks. Instead, the ex-Navy flyer acquired patent rights for a solar-heater system, modified it, and put the sun to work warming his pool.

Now, after several seasons of tests, Freeman is marketing his easily installed solar-heating system nationwide. In many locations it can replace a gas heater; in other areas it can provide supplementary heat to reduce gas bills. Initial cost is somewhat higher than a gas heater for the same pool, but the payoff is the gas bills you don't get.

Basic component of the system is a 3½-by-8- or 10-foot panel made of sections of black ABS plastic extrusions with a coarse honeycomb cross-section. Each panel, in effect, is a bundle of flat, black pipes, durable and highly effective at converting the sun's energy into heat. On a warm day, system output is 10,000 Btu per panel per hour. It even works, though less effectively, with haze or light overcast.

Volume heating. Panels are installed at a sloping angle, and water enters them from the bottom, rises through the heating channels, and returns from the top.

Typical heat rise through the panels (the difference between input and output) is from two to five degrees. That's not dramatic, but the system works on the basis of continuous, high-volume water heating.

Between sunlight periods, the solar-heating cycle is bypassed and the pool acts as a heat reservoir. If the outdoor temperature swings between 50 and 90 degrees daily, the pool typically gets up to 80 degrees and stays there (within one or two degrees) day and night.

Panel area. A decision to use the solar heating system should depend on the availability of space for the panels. Space requirements will vary according to the size of the pool and the temperature you want.

In California, where the system was first marketed, the rule of thumb is to provide an area of solar panels equal to at least half the surface area of the pool, or 400 square feet of panels for an 800-square-foot pool. This should keep the pool at about 80 degrees during the summer

[Continued on page 168]

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It could make your next party the best you ever had . . . or the last

Electronic "Lie Detector" Tells It Like It Is

By C. R. LEWART

Honesty is the best policy—that's what people say, but is that what they honestly believe? At your next party, find out—at their expense—with this electronic lie detector.

In just a couple of short building hours you'll have a party gimmick that will create fun and—maybe, if your volunteers are less than candid—some revelations.

Although we don't suggest you camp on the couch because of something the meter reveals about your spouse's truthfulness, we can say that our lie detector is based on a well-observed scientific fact.

Your electrical body resistance changes with the degree of mental stress. And, generally, a truthful answer is less strenuous than an evasive one. Your lie detector, therefore, simply measures this small change, amplifies it, and displays the differences—for all to see—on a meter.

You're in the circuit. Your body acts as part of a bridge circuit at the input of the operational-amplifier IC. The CAL potentiometer offsets the bridge to supply a calibration voltage point on the meter.

As your body resistance changes, however, so does the voltage across the bridge. The IC then detects this small change and drives the meter to display the result. Output resistors and diodes are for protection and limit the current flow to the meter, in case of a whopper.

Mount the components on a perforated board with hole spacings to match the IC socket. Wiring is not critical, but keep the leads as neat as possible.

Lettering the meter face is simple. Remove the faceplate and glue our cutout meter face over the existing one; or, if you've got spicier terms, make your own.

It's an easy job. You can build the circuit in a 3½"-by-5"-by-10" cabinet with a big, legible meter, as shown, if you're after a crowd-pleaser. If you wish, use miniature equivalents of all the components to make a pocket-size unit. (We do not have an equivalent parts list, but your local electronics dealer can make the substitutes.)

Good electrical contact with the victim's skin is important. Bicycle clips have sufficient gripping power, and they won't be uncomfortable. Salve to moisten the skin will also help—although it's not crucial, and it's a nuisance at parties.

The best type of subject for the detector is one who is slightly ner-

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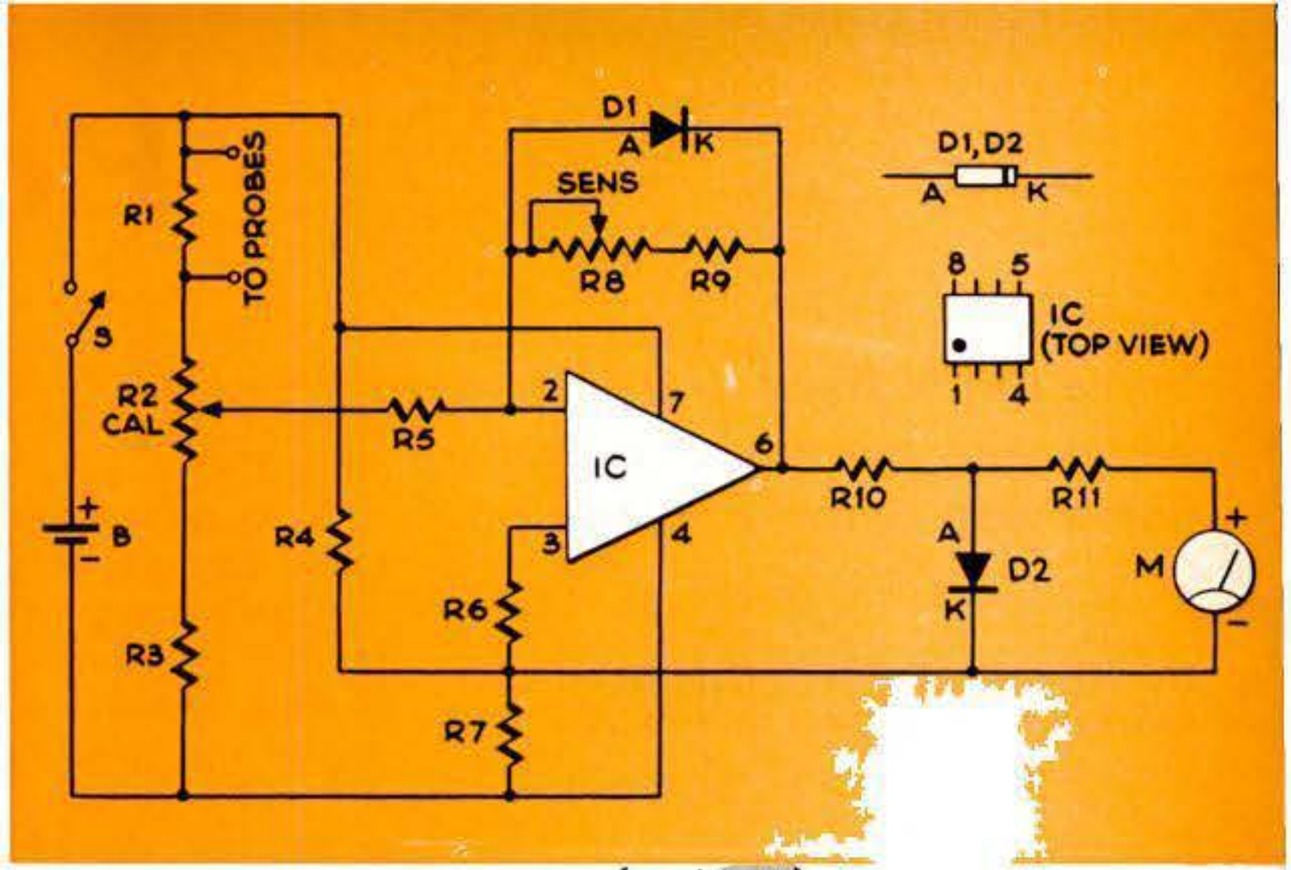
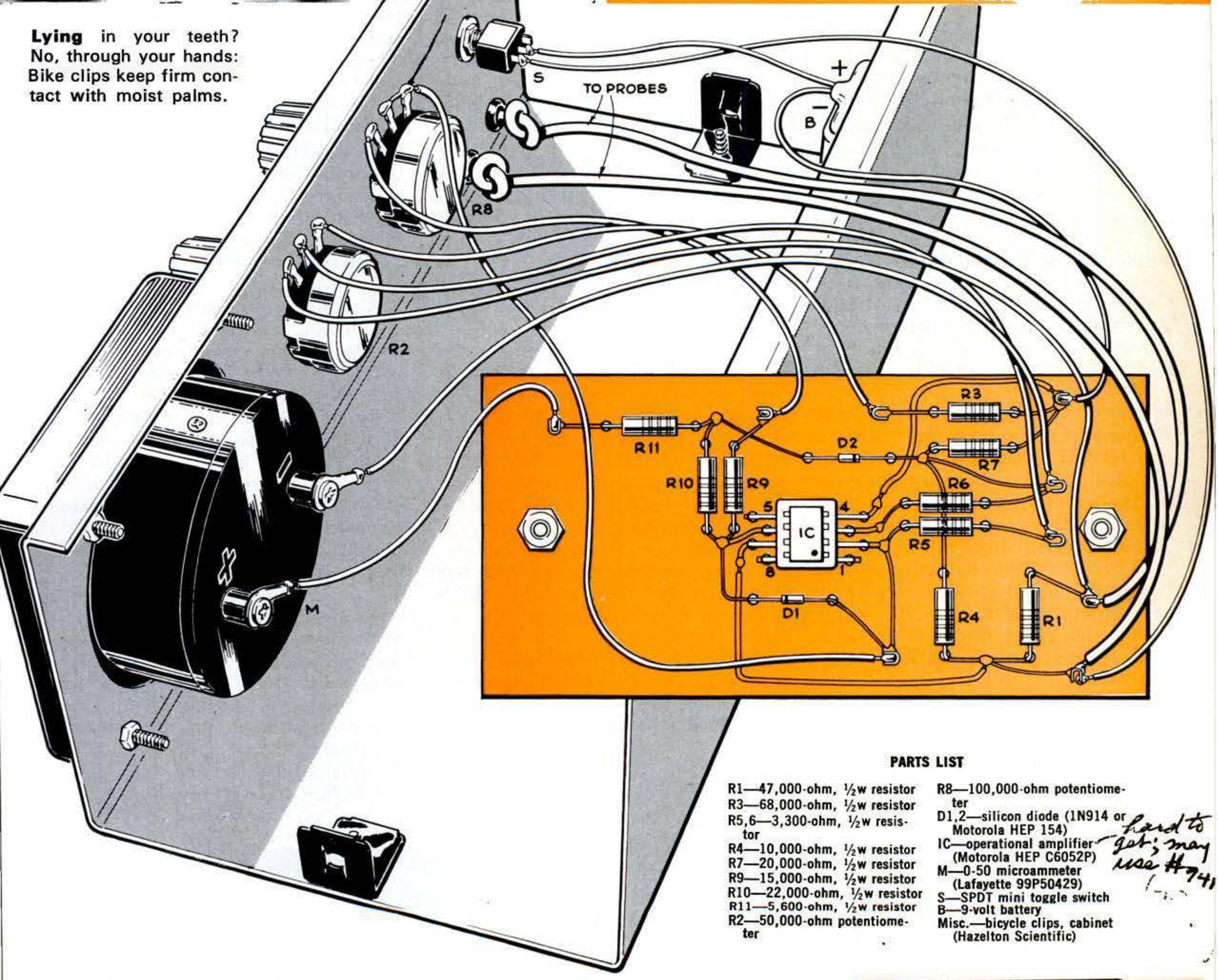


Lying in your teeth? No, through your hands: Bike clips keep firm contact with moist palms.



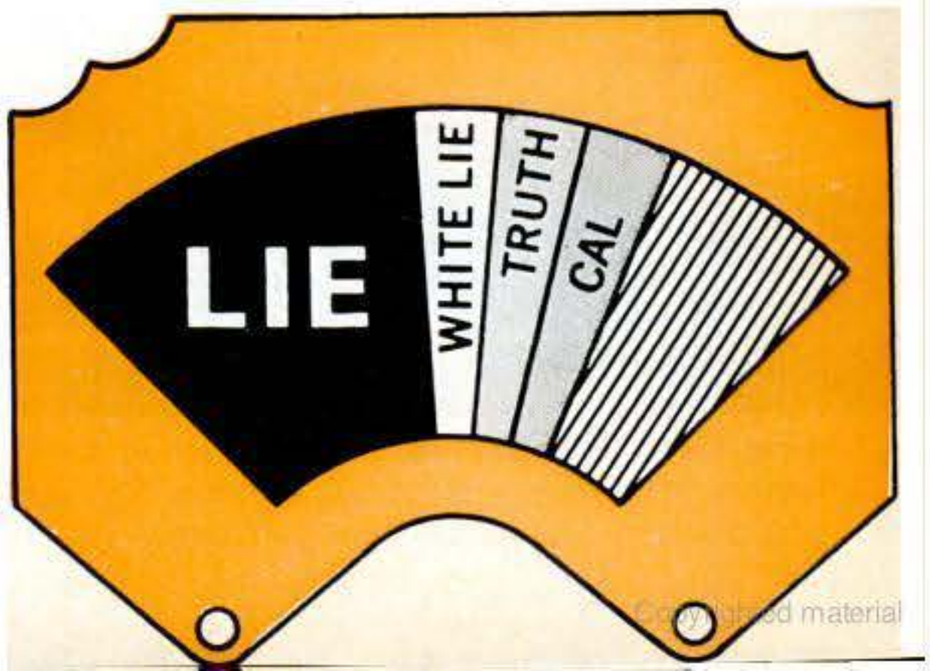
PARTS LIST

R1—47,000-ohm, ½w resistor
R3—68,000-ohm, ½w resistor
R5,6—3,300-ohm, ½w resistor
R4—10,000-ohm, ½w resistor
R7—20,000-ohm, ½w resistor
R9—15,000-ohm, ½w resistor
R10—22,000-ohm, ½w resistor
R11—5,600-ohm, ½w resistor
R2—50,000-ohm potentiometer
R8—100,000-ohm potentiometer
D1,2—silicon diode (1N914 or Motorola HEP 154)
IC—operational amplifier (Motorola HEP C6052P) — hard to get; may use #741
M—0-50 microammeter (Lafayette 99P50429)
S—SPDT mini toggle switch
B—9-volt battery
Misc.—bicycle clips, cabinet (Hazelton Scientific)

vous and whose hands are partially sweaty. All set? Turn the power on and the SENSITIVITY half-way up. Adjust the CAL control to the calibrate position on the meter and ask your cooperative friend to answer a few questions truthfully.

Keep the questions simple at first, to elicit yes-or-no answers. Each time he answers, you will notice a dip in the meter. Adjust the SENSITIVITY control so the dip reads as truthful on the meter face. Now, hit him with a zinger. Besides the meter indication, you'll see how uncooperative your ex-friend can become.

Even professional lie detectors—which measure not only skin resistance, but also blood pressure, breathing rate, and pulse—make mistakes and can be fooled by an experienced subject. But, at a party, with the right questions, who do you think they'll believe? PS



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How to Cope with

Some quick fixes to try when your camper or motor home won't start or won't go

By HERBERT SHULDINER
ILLUSTRATIONS BY RAY PIOCH

For more than a year a fleet of recreational-vehicle service vans has been cruising around the country to bring emergency aid to disabled RVs stranded on our highways. The vans are manned by mechanics with specialized training to help RV owners who encounter serious mechanical difficulties with their rigs.

I recently spent several days with the RV experts who man the Dodge service vans, to find out what RV mechanical emergencies they most frequently encounter–and what temporary fixes are possible to keep you going until you can reach a spot where permanent repairs can be made.

One of the men I spoke to was Richard Cursi, assistant service manager of Dodge's truck division. He told me that the most common breakdowns involved the ignition system. Other frequent emergency situations result from a broken radiator, heater or power-steering-system hoses, fan belts, speedometer cable or gearshift linkage; faulty water or fuel pumps, blown fuses, carburetion problems, dead batteries, defective wiring, and brake difficulties.

Cursi says most of these ailments can be diagnosed and cured when you are out in the rough–if you're knowledgeable and carry a basic kit of tools and spare parts. More important, most of them can be prevented by proper maintenance.

Here are some troubleshooting tips Cursi recommends:

Can't-start tips. Check the points, spark plugs, and condenser if your rig won't start. Carry replacements and know how to install them. A good way to check breaker-point gaps if you don't have a feeler gauge, says Cursi, is to use a matchbook cover. The cardboard thickness gives you roughly the right gap.

Dampness inside the distributor cap can also be the culprit when your motor home won't start. Wiping out the inside of the cap with a dry, lint-free cloth often helps.

Faulty ignition wires can also cause starting problems. It's a good idea to include some spares in your emergency kit. And wrapping insulating tape around burnt or cut spots, if you don't have a spare, can help prevent arcing.

A dead battery, of course, is one of the most common can't-start causes. Most large RV rigs have dual battery setups wired in parallel. Never run your appliances off both batteries simultaneously. Disconnect one battery when camping so that you always have a live one to power your rig's starting motor.

What else can drain your battery? A broken, glazed, or improperly tensioned fan belt is a possible cause. A defective voltage regulator is another. The regulator should be replaced at the first opportunity if it proves to be the culprit. Carrying a spare fan belt can also save you a lot of headaches. A broken fan belt will not only stop the alternator from charging your battery, but the water pump from circulating coolant, allowing the engine to become overheated.

A malfunctioning starter solenoid is another thing that can keep you from starting–maybe due to a stuck plunger, which can sometimes be dislodged by tapping it with a rubber or plastic mallet, or a chunk of wood if nothing better is available.

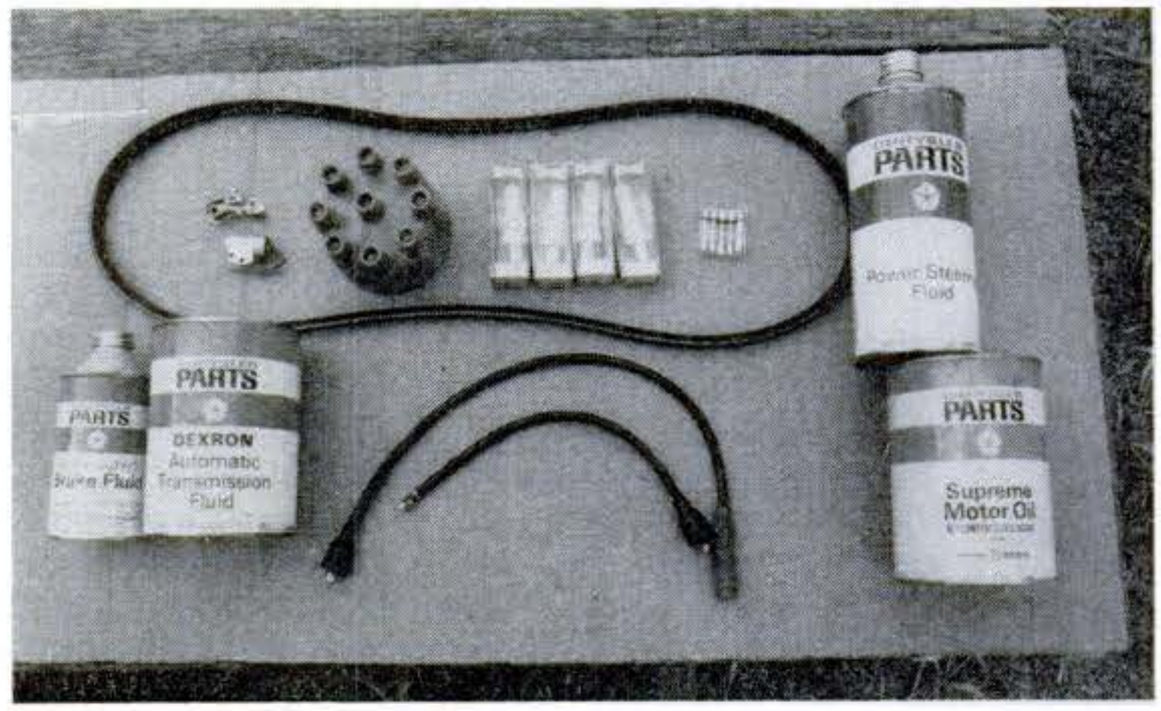
These are things that you can fix if you're on your own in the sticks. However, a faulty starter is probably more than the average RV owner can hope to tackle. The alternator is another part that's beyond emergency fixing.

But you can check the connections between these parts and the things they run. Check for tightness, breaks, and corrosion. Breaks can be repaired with a knife and tape. Corrosion can be removed with a piece of emery paper–even with a pocketknife or a nail file.

Although the can't-start troubles are among the most serious emergencies RV'ers encounter, there are numerous other problems that can crop up while you're on the road.

Hose failure. This is one of the most frequent causes of this sort of trouble. Breaks in radiator and heater hose can cause loss of coolant, making your already hard-working rig overheat. Cursi suggests that plastic tape wound around a broken hose will often hold long enough to get you to a station where you can buy a replacement hose.

The power-steering hose is another that may fail. It, too, can be tape-wrapped to revive and keep operative your power steering until you reach a service station. You should also carry aboard a supply of power-steering fluid to replace any that's lost before you repair the hose. Use



New fleet of service vans launched by Dodge will aid RV owners requiring emergency service. RV service experts manning vans recommend that you carry supplies shown above, right, to cope with on-road emergencies: brake, transmission, and power-steering fluids; motor oil, ignition wires, fuses, fan belt, plugs, condenser, points, distributor cap.

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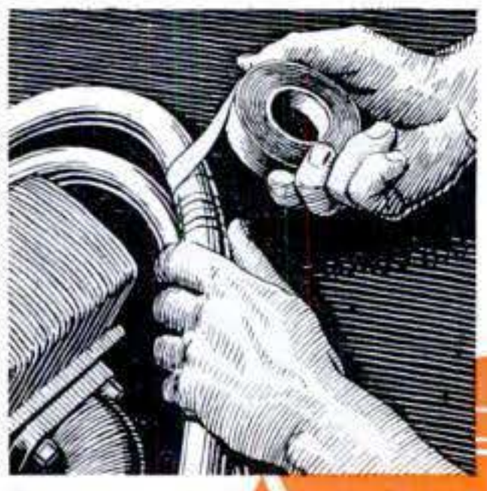
Those RV Emergencies

power-steering fluid only, not transmission fluid as some people do. Transmission fluid can damage the hose and the seals in the system, Cursi warns.

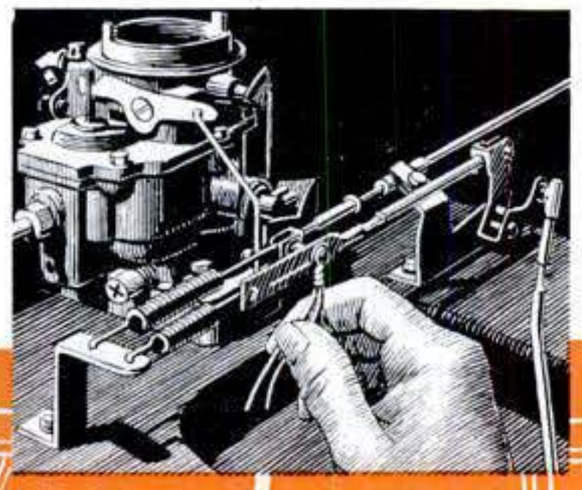
Should the gearshift linkage break, you may face a more serious problem. If a cotter pin has been lost, you can make a temporary fix with steel wire. But if a rod or joint is broken, you'll need a mate to hold the brakes on while you crawl under to move the shifter.

Attach a wire to the shift lever (near the transmission) with the engine dead. Be sure the emergency brake is on and tightly set before you crawl under the chassis to attach the wire. Then stand clear as the engine is started by your helper. Yank the wire forward for drive, and back for reverse. This will enable you to get to a repair shop.

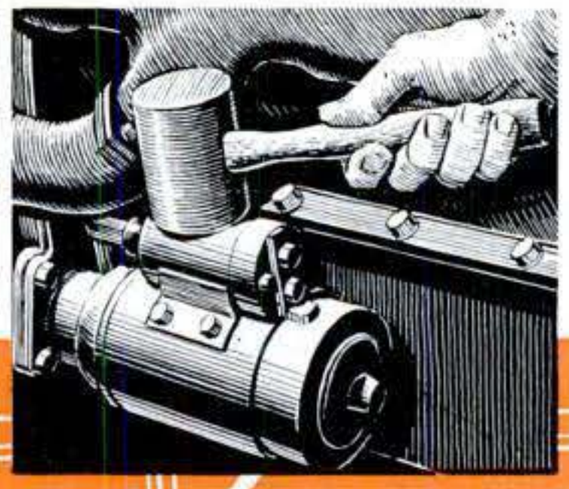
[*Continued on page 170*]



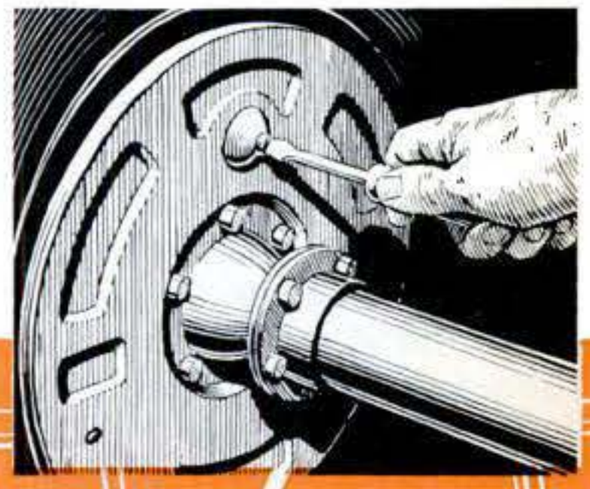
Damaged heater hose can be temporarily repaired by winding plastic tape around (as shown). This should hold until you get to a service station.



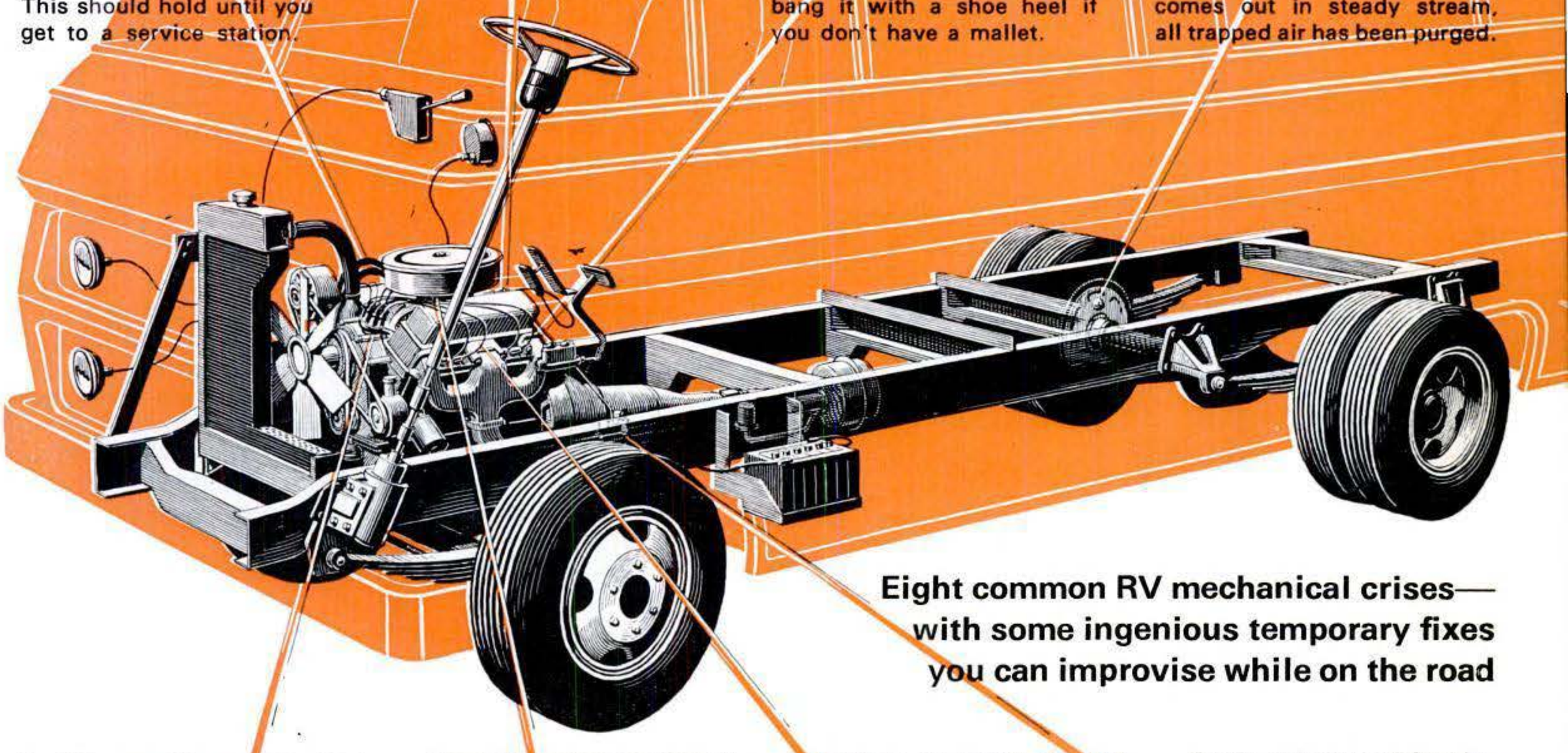
Hold-on clip for throttle-return cable can sometimes fly off. Wire it back for control until clip can be replaced.



Rapping a solenoid with a rubber or plastic mallet can dislodge stuck plunger that prevents starting. Or you can bang it with a shoe heel if you don't have a mallet.



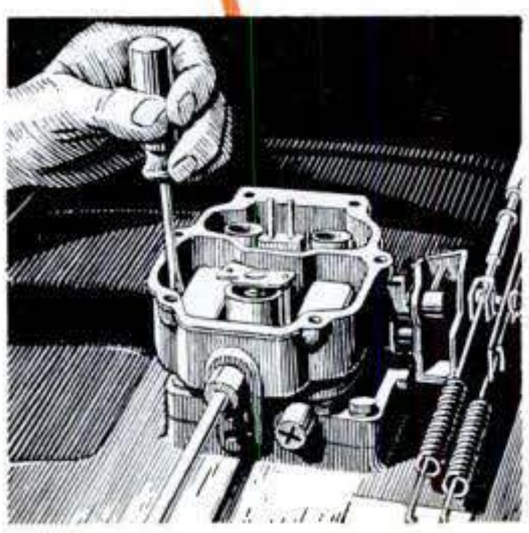
Bleeding the brakes can correct sponginess. Have someone step on brake pedal while you open screw. When fluid comes out in steady stream, all trapped air has been purged.



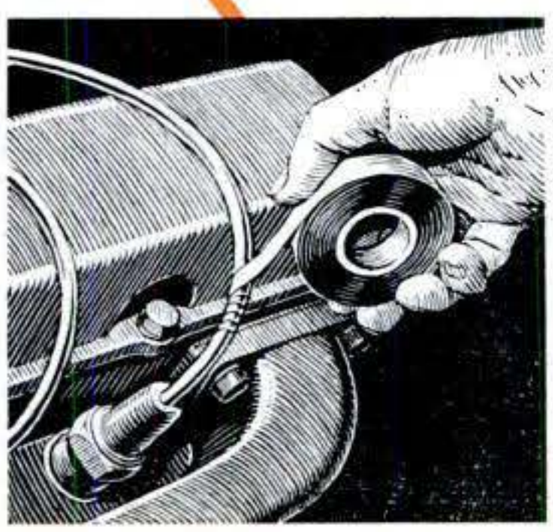
Eight common RV mechanical crises—with some ingenious temporary fixes you can improvise while on the road

Ignition problems are most common no-start cause. A new condenser and points often help; also wiping out dampness in the distributor cap with a dry, lint-free cloth.

Float in Holley carburetor can stick, flooding the engine. Use a screwdriver to close float manually to prevent excessive gas from flowing into the carburetor.



Cracked or burnt ignition wires are repaired easily with tape to prevent arcing. The patched wires must later be replaced to effect a satisfactory permanent fix.



Can't get into drive because gearshift control linkage is broken? If you have helper to step on brakes, you can move shifter manually from under chassis.

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Finish the 'Bedroom' of the

Double bed folds into rear extension built on rehinged back doors of our van, first shown on last August's cover

By E. F. LINDSLEY / *PS Midwest Editor*

DRAWINGS BY CARL DeGROOTE

The entire concept of the PS Dodge Camper Van—as presented in our August '72 issue—depends on a light, full-length bed that will fold to an exact fit in the rear canopy. We found commercial beds either too flimsy, too heavy, too wide, or they bent in the wrong places, or posed exasperating problems in shortening and rerigging springs. So we designed and built the bed shown here. It's light and rigid, the legs fold automatically, it fits—and if you're extra tall you could make it a foot longer without any problem.

Start by cutting the 1¼" tubular sides to exact dimensions. A tubing cutter leaves a cleaner end than a saw. Be certain tubes and hole locations on opposite sides are identical. Clearances are close; errors will magnify into serious misalignments when you fold the assembly. The 1¼"-angle end pieces must also be precise. Note that those tubular webbing supports fit inside the end pieces between side members and can be final-riveted only after webbing is in place. Thus, in order to work out assembly of the corner plates as you go along, you should drill and deburr the 3/16" rivet holes in the angles and plates, then drill smaller holes for temporary sheet-metal screws in the tubing.

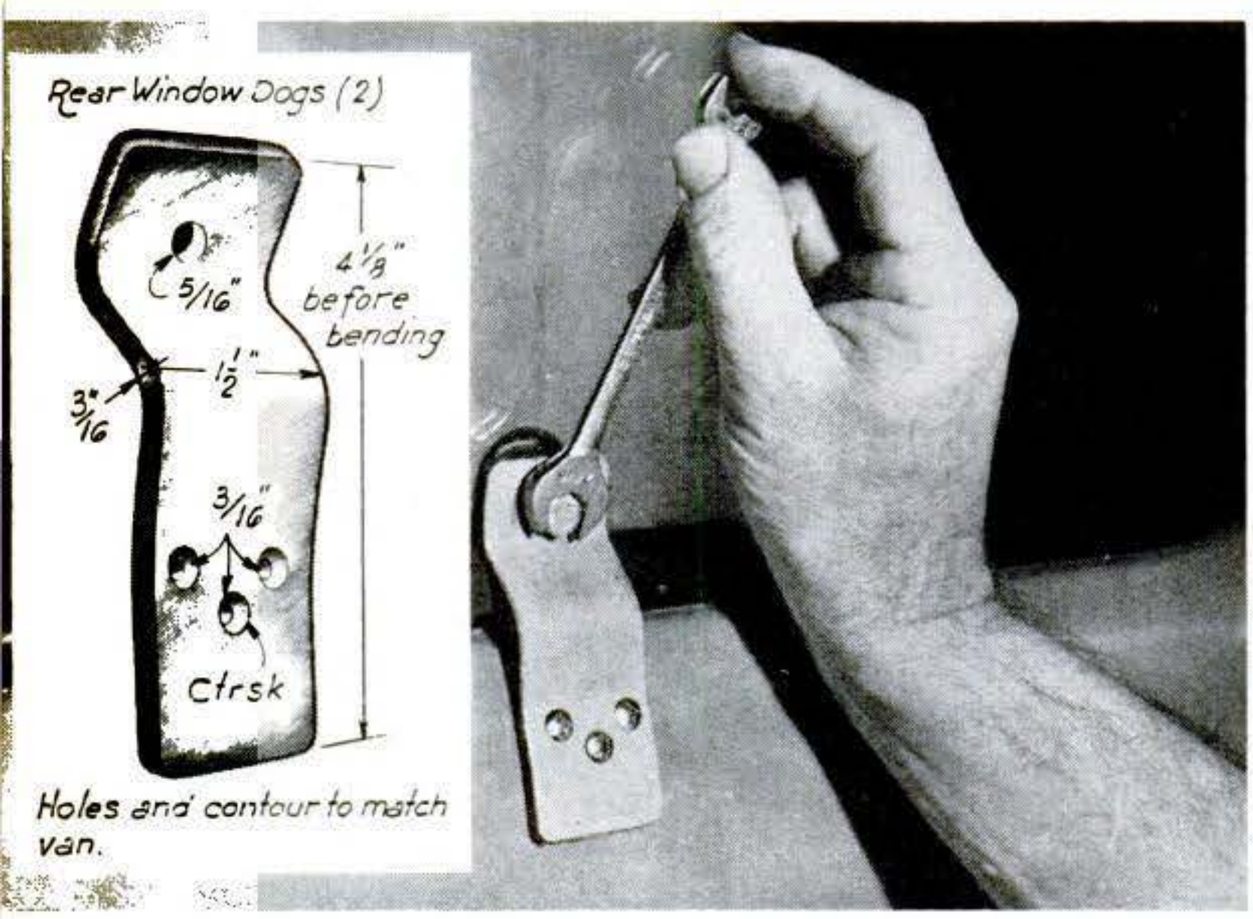
The bent center hinges and leg supports were formed by first making a series of small crimps in a bench-size sheet-metal brake. The rest of the bend was made by muscle power and a little prudent tapping with a hardwood block over a mandrel. We recommend torch annealing the .09" aluminum, as described in the PS plans (see box at end for ordering information). Drill the holes clear through after bending so they'll be dead-opposite each other.

Make sure of clearance. With the bed frame temporarily screwed together, mount the rear-end hinge and make a trial installation in the van. This will show you any problems or interference with the lower canopy structure. You should have about 3/8" clearance on each side. Block the frame into level position and measure from pivot holes to van floor to determine leg length. Leg dimensions will differ if your rear door folds down to an angle even slightly different from ours. The front legs will be trimmed later to match the finish floor.

We used plastic webbing for the long strips and heavy cotton webbing for the cross-pieces. Grommets beef up the holes for pan head sheet-metal screws.

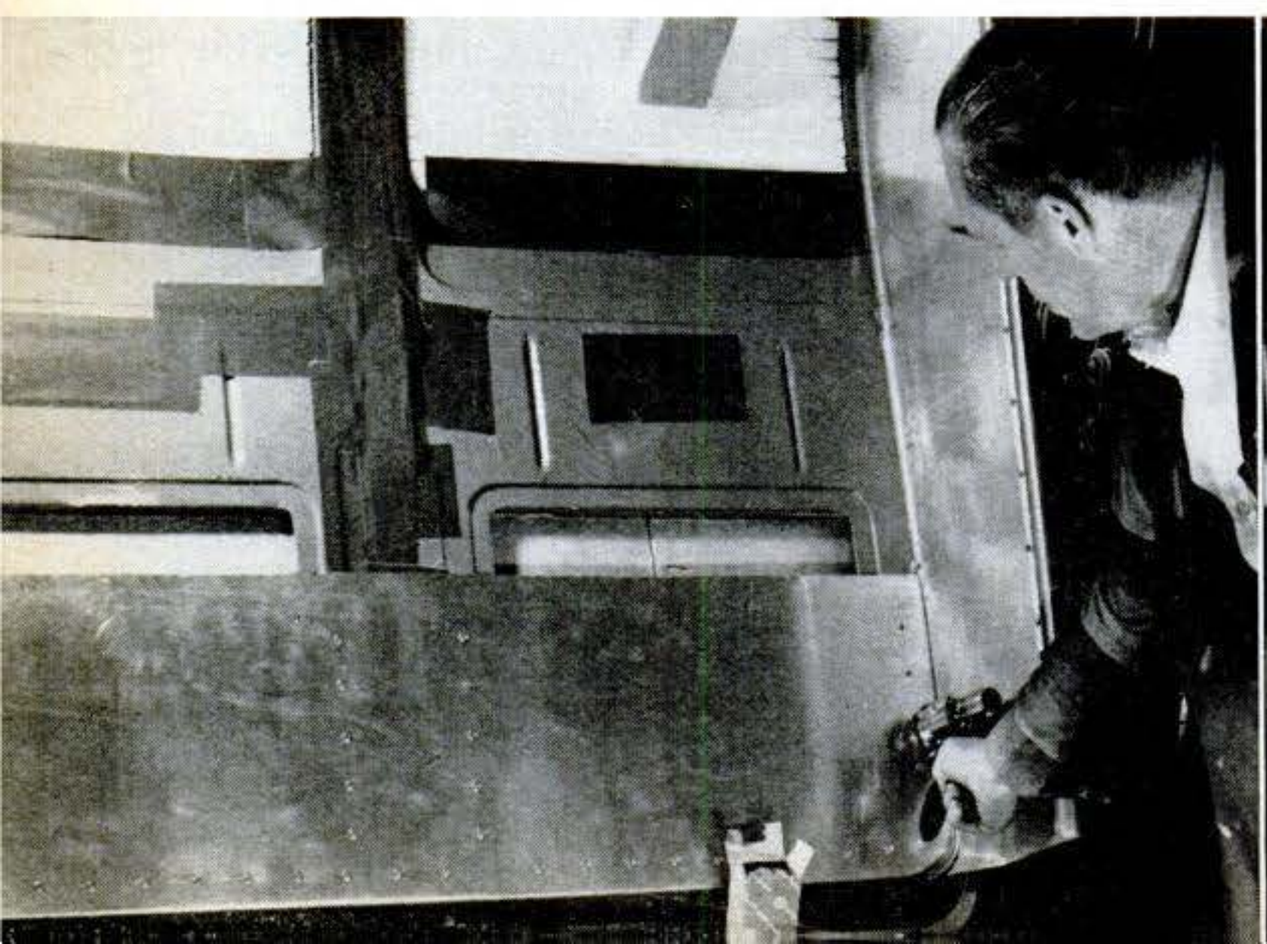
To be sure that all web strips are the same length between grommet centers, drive nails in a board and nip off the heads. Install grommets in the free end of the webbing and slip them over the nails. Snug the strip to the matching nails at the other end and push the nails through to mark the grommet centers. We cut the grommet holes with a piece of sharpened tubing chucked in a drill press. The setting anvil and die come in the envelope with the grommets. Dope the cotton webbing ends with shellac to prevent fraying.

With the long webbing strips on one support tube you



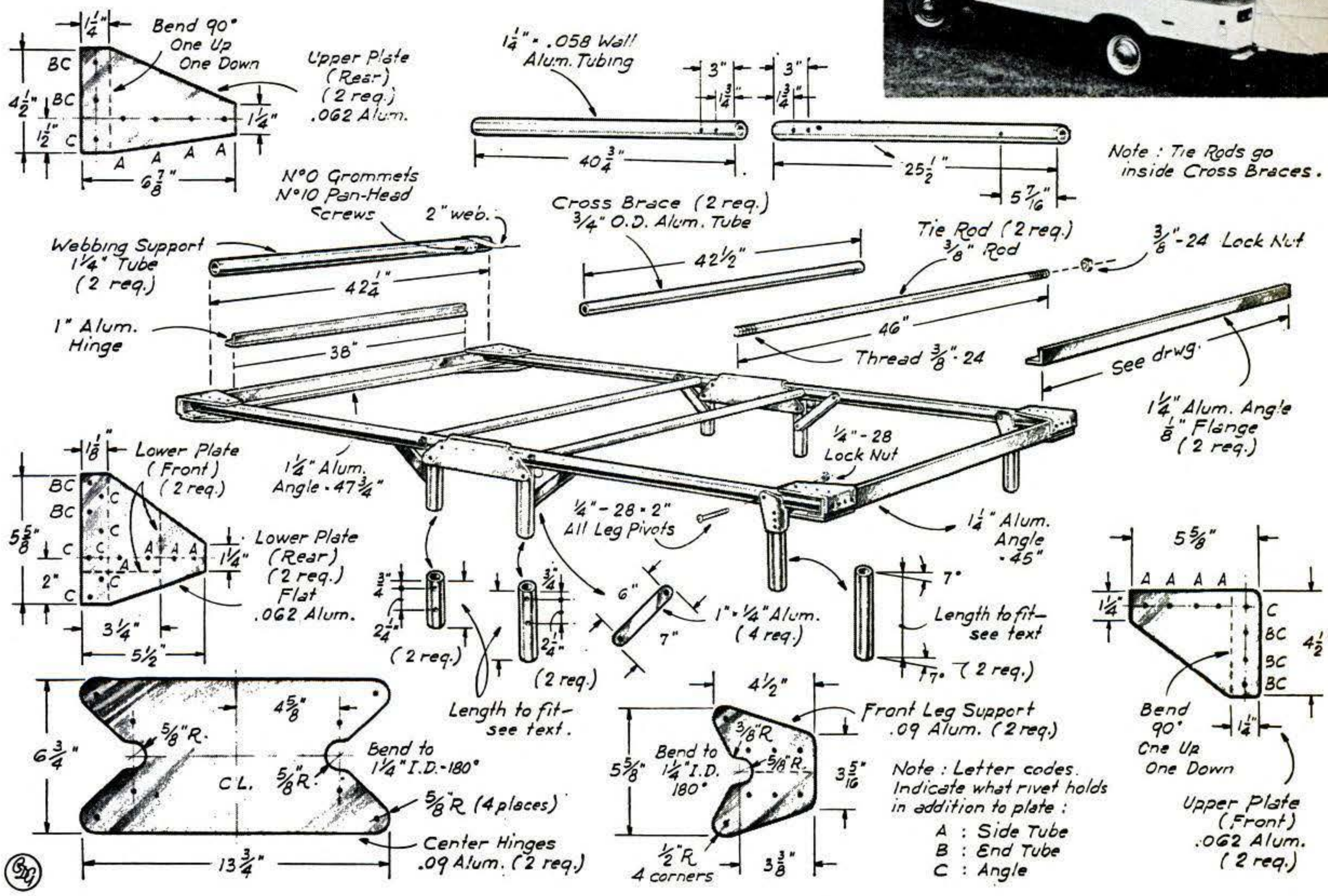
Rear windows are closed permanently with these dogs. Unscrew the original toggle latch, install the bent strip, and firmly but gently bolt the glass down against seal strip.

Cold drafts won't give you cold feet if you insulate and seal the back. Line doors with two layers of 1½" foam. Cut blocks to stagger seams. Cloth tape 4" wide is good around door hardware. Seal corners with self-curing rubber caulk.



Inner door panels of .032" aluminum sheet unite the two doors into rigid unit. Pop rivets hold them together. You can fit a single sheet, but the curve and tight working space make two pieces easier. Outdoor carpet finishes floor.

Stretched Van Camper



can finish assembly of frame end, replacing temporary screws with pop rivets. The drawings show which parts each rivet holds.

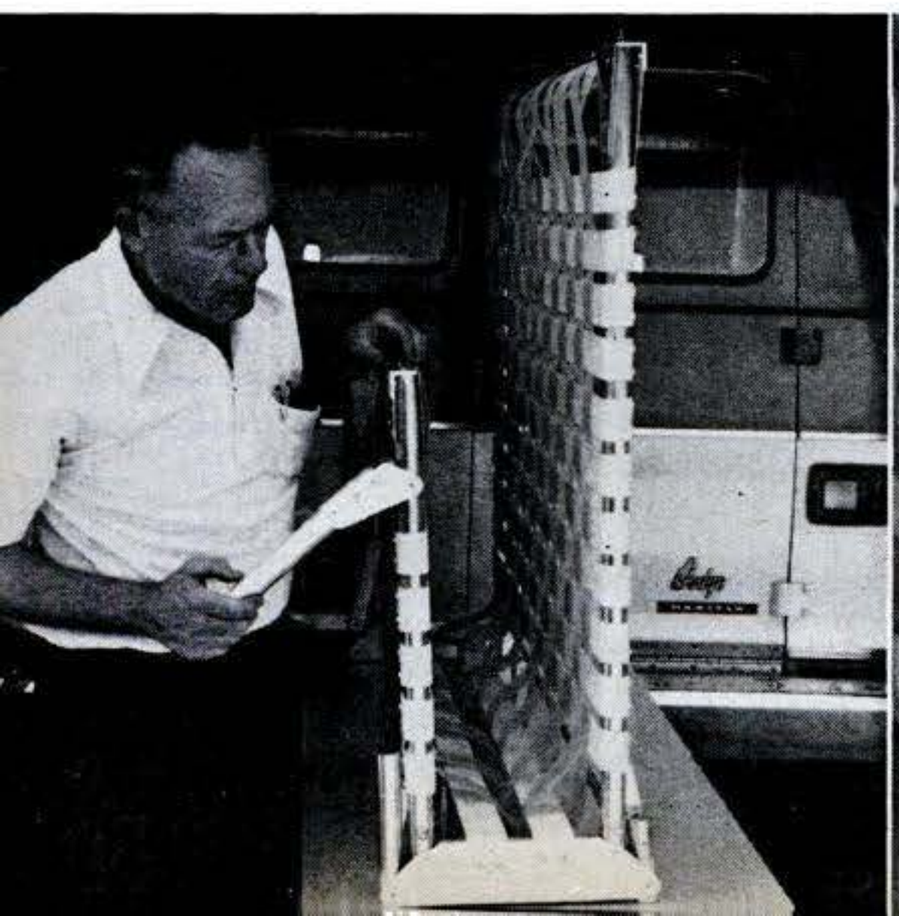
The other end of the bed is made the same way, except the webbing support tube has to be twisted to tighten the "bed springs" and clamped while you drill rivet holes. Or, you can install the support tube with webbing held temporarily, then, after the support tube is in place, pull each strand taut, drill holes for two sheet-metal screws, and screw down. Add cross-webs last.

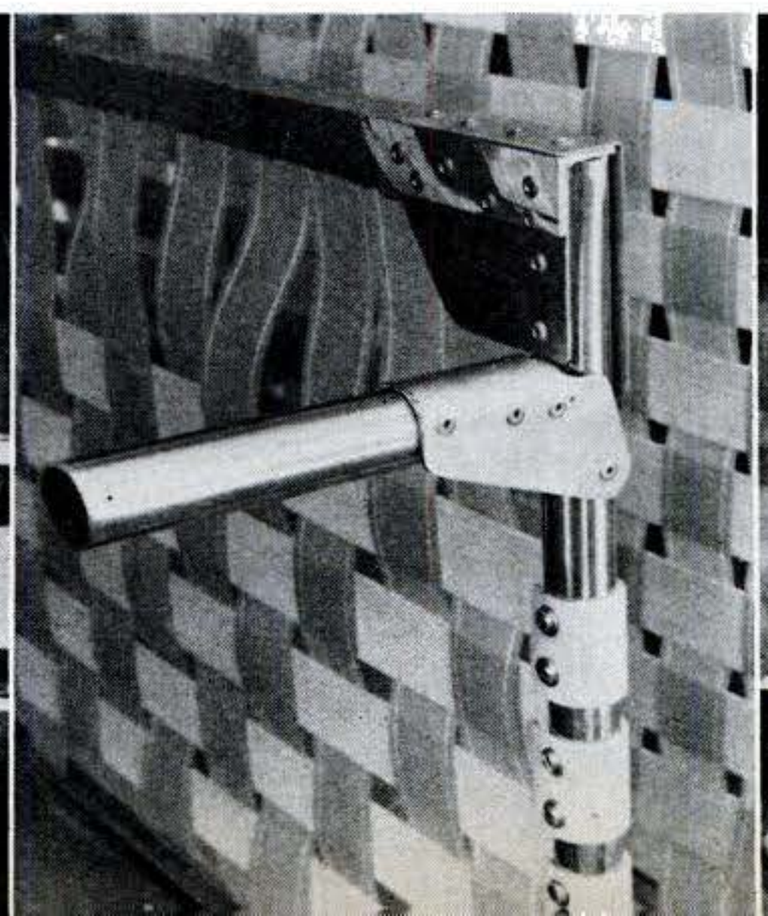
The photos show pop rivets in the various pivot holes. These were only for checking purposes. Once sure that bed and legs all worked properly, we drilled out the rivets and replaced them with [Continued on page 166]

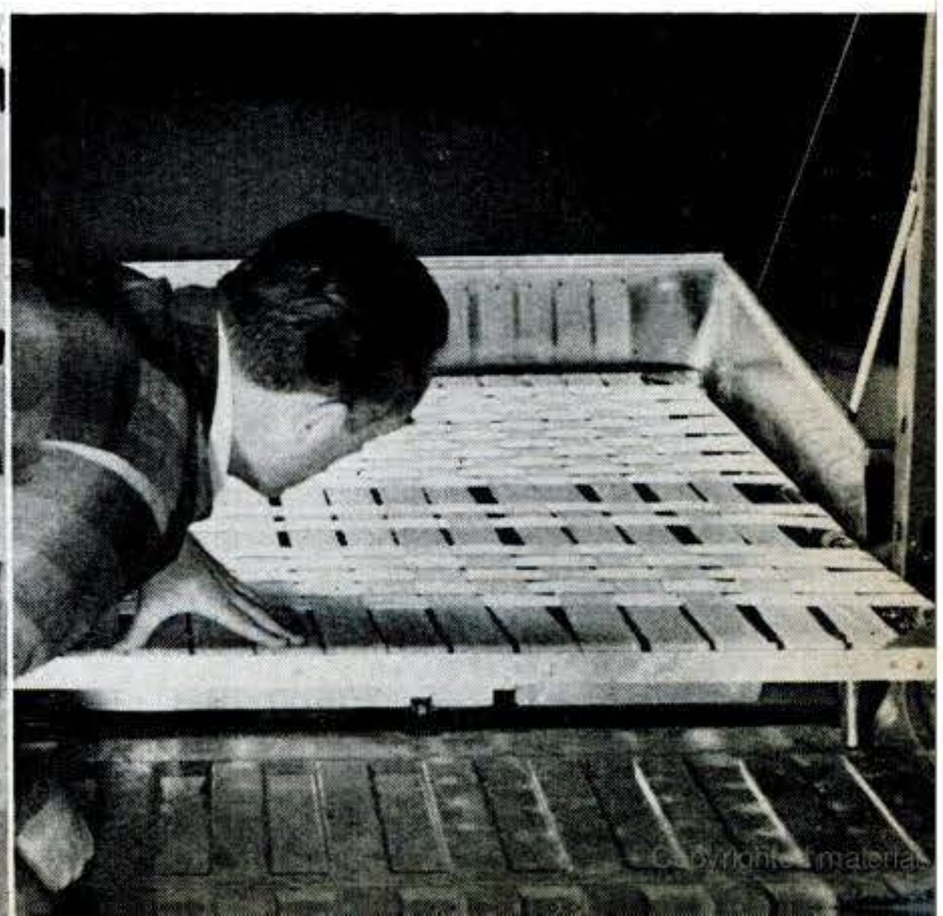
Folding action amplifies misalignments, so be careful when drilling rivet and pivot holes. Everything must be square or bed won't fit with ⅜" clearance.

Pop rivets hold all stationary joints in aluminum tubes, angles, and plates. Rivets at pivots are for checking only. Pan head sheet metal screws hold webs.

Leg lengths depend on exact angle of rear platform. Measure from each leg pivot to floor after blocking bed level. Shorten legs as you finish floor.







Extend Your Plumbing with

Indoors or out, hot water or cold, whatever your plumbing job, it's easier and cheaper with plastic pipe

By A. J. HAND / *PS Home Workshop Editor*
DRAWINGS BY HANK TOMKALSKI

You say you'd like to do your own plumbing around the house, but you don't have the tools or the know-how to try? Well, you've just lost all your excuses. With today's plastic pipe and fittings, you can do nearly any plumbing job you want—the easy way—without special tools or sophisticated techniques. No soldering, no pipe threading, no fooling with molten lead.

And to make things even easier, major plumbing manufacturers are setting a trend by putting their products where you can find them—in hardware and do-it-yourself stores, racked (as at right) for easy selection

Installing a mud sink in 12 easy steps with CPVC and ABS pipe

1 First step in any extension job is to tap into your existing hot and cold water lines. If lines are copper, the job is easy with a compression T (same size as your copper pipe). Turn off water. Cut out a section of copper line equal in length to the distance between the shoulders inside the T. Slip the T in place in the line and tighten compression nuts. If lines are galvanized, remove an elbow and replace it with a galvanized T. Work near a union.

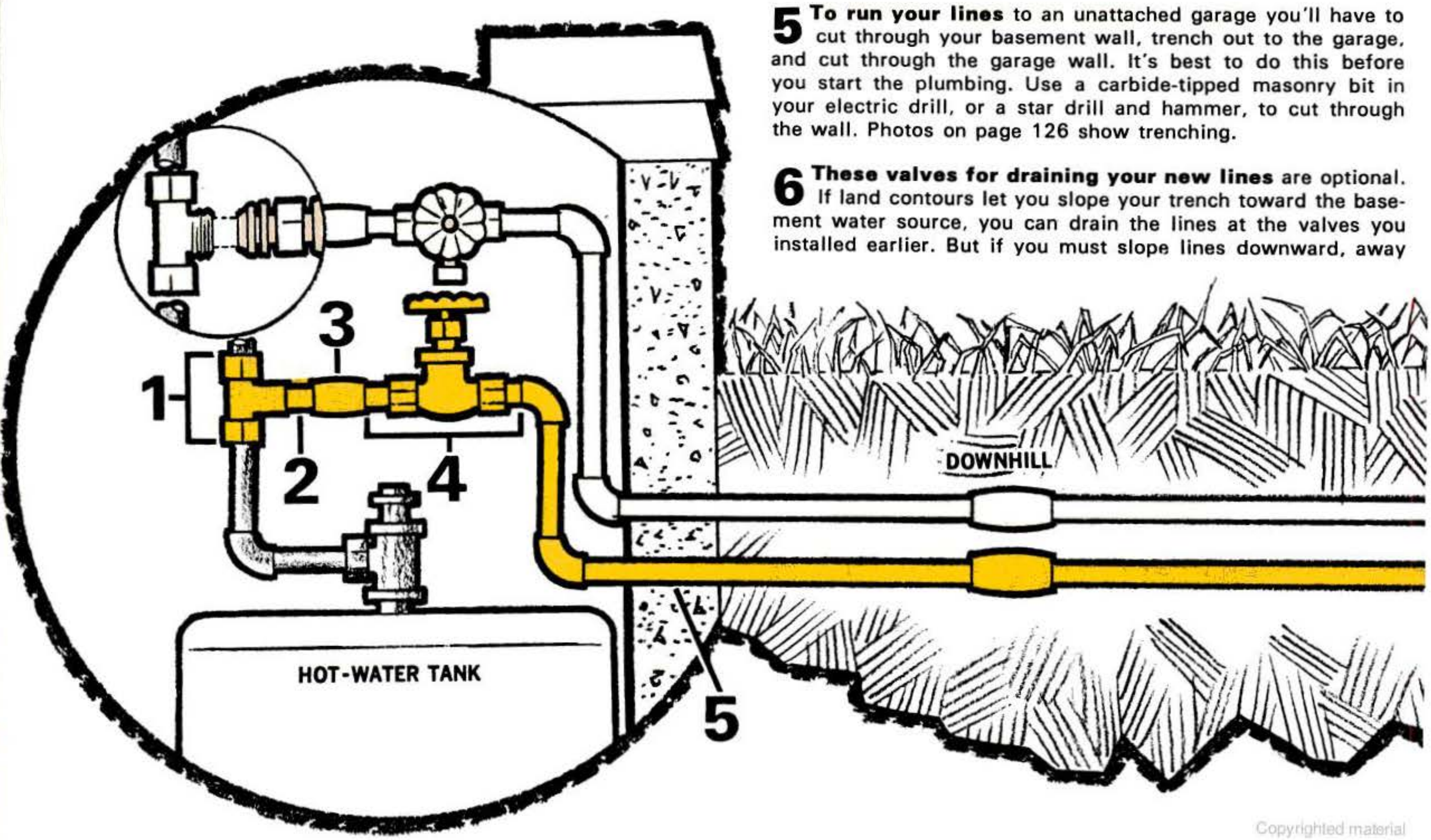
2 Now you're ready to make the transition from metal to plastic pipe. You do so with a transition fitting (Nibco's part number 4732-2). To fit it to the T you installed in step 1, coat the rubber O ring with Vaseline (don't use ordinary pipe dope), slip it into the T, and hand-tighten the nut. Then use a wrench to tighten it another half turn.

3 Next comes a coupling: It cements to the plastic end of the transition fitting you just screwed in place. This cementing is done at all plastic-to-plastic joints, but we'll only describe it once. Begin by cleaning and softening end of transition fitting and inside of coupling. Wipe both pieces dry with a clean rag, then brush on a coat of CPVC primer to soften plastic. Coat the outside of transition fitting, the inside of coupling; then brush a coat of CPVC solvent on both pieces. Quickly slip coupling onto fitting and twist a half turn to distribute the cement. Check alignment of parts, then hold 15 seconds. Wipe off excess solvent with a clean rag and check for an even bead of solvent around joint. The bead is vital for a tight joint.

4 A stop and waste valve comes next. It lets you shut off and drain the new line in winter. Easiest to install is Nibco's 4476. It threads directly onto the same type of transition fitting described in step 2. To hook the valve into the line, assemble a transition fitting into each end following step 2. Then solvent-weld it into the coupling you installed in step 3. Remember to install the valve with its arrow pointing in the direction the water will flow. With valve in place, cement an elbow (or a coupling if you want a straight run here) onto the free transition fitting sticking out of the stop and waste valve. Now you can begin your run. This involves merely cementing together sections of pipe with coupling, using elbows wherever turns are required.

5 To run your lines to an unattached garage you'll have to cut through your basement wall, trench out to the garage, and cut through the garage wall. It's best to do this before you start the plumbing. Use a carbide-tipped masonry bit in your electric drill, or a star drill and hammer, to cut through the wall. Photos on page 126 show trenching.

6 These valves for draining your new lines are optional. If land contours let you slope your trench toward the basement water source, you can drain the lines at the valves you installed earlier. But if you must slope lines downward, away



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Plastic Pipe

of the parts you'll need. Assuming local codes allow the use of plastic pipe in your area, you're all set.

To show you how easy plumbing is with plastic pipe, we asked Nibco, Inc. (the company with the most complete line of plastic plumbing supplies) to run through a plumbing-extension job from start to finish. The job we picked? Installation of a mud sink in an unattached garage. You can see the whole job diagramed below.

We picked this job because it includes about every problem you'll ever encounter in an extension installa-

Continued

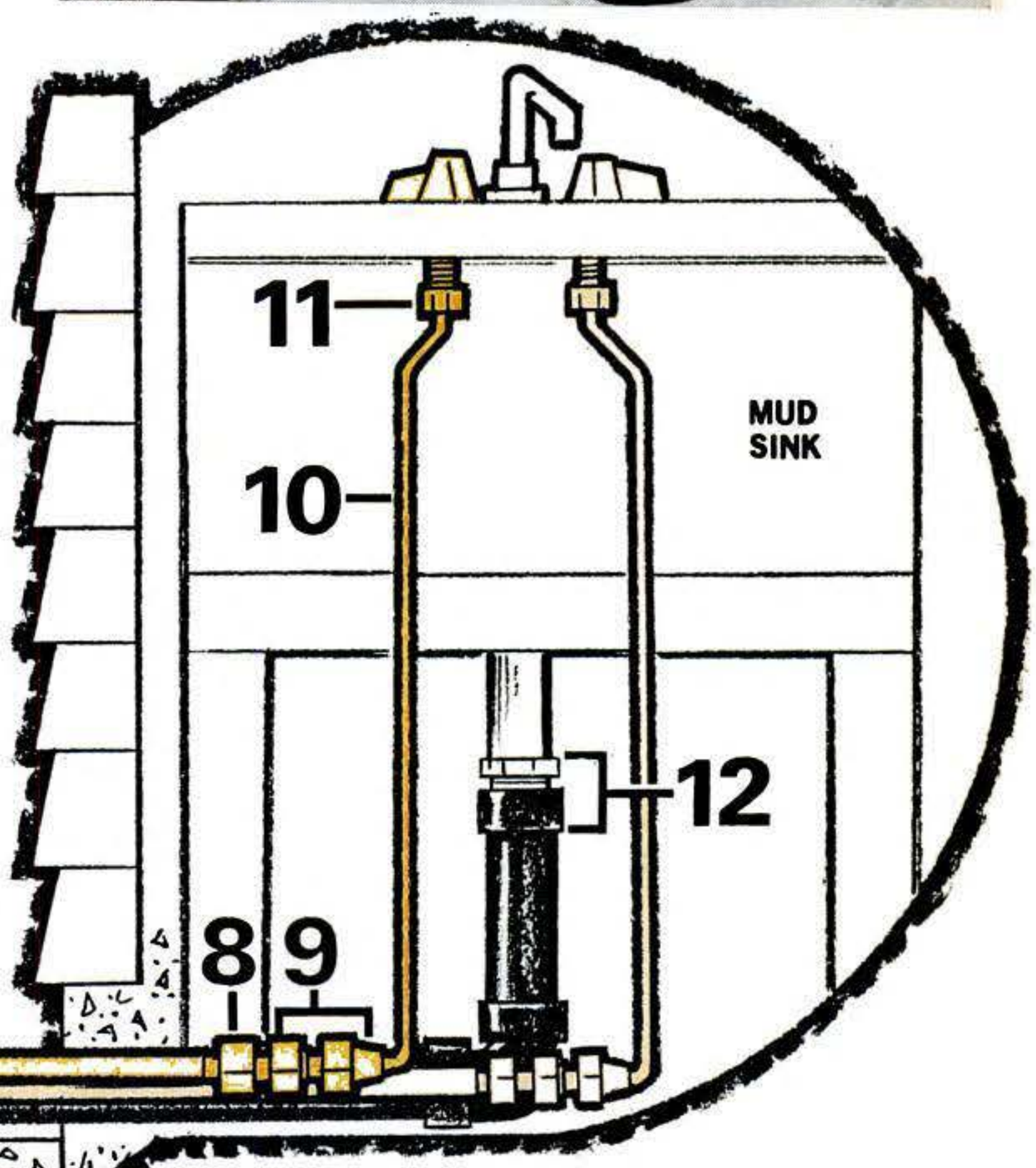
from the source, install another pair of valves (#4476) as shown here. Install them off Ts cemented into the lines, and use the same type transition fittings (#4732-2) used earlier. As shown here, these valves are located below ground and drain into a concrete-block-lined dry well.

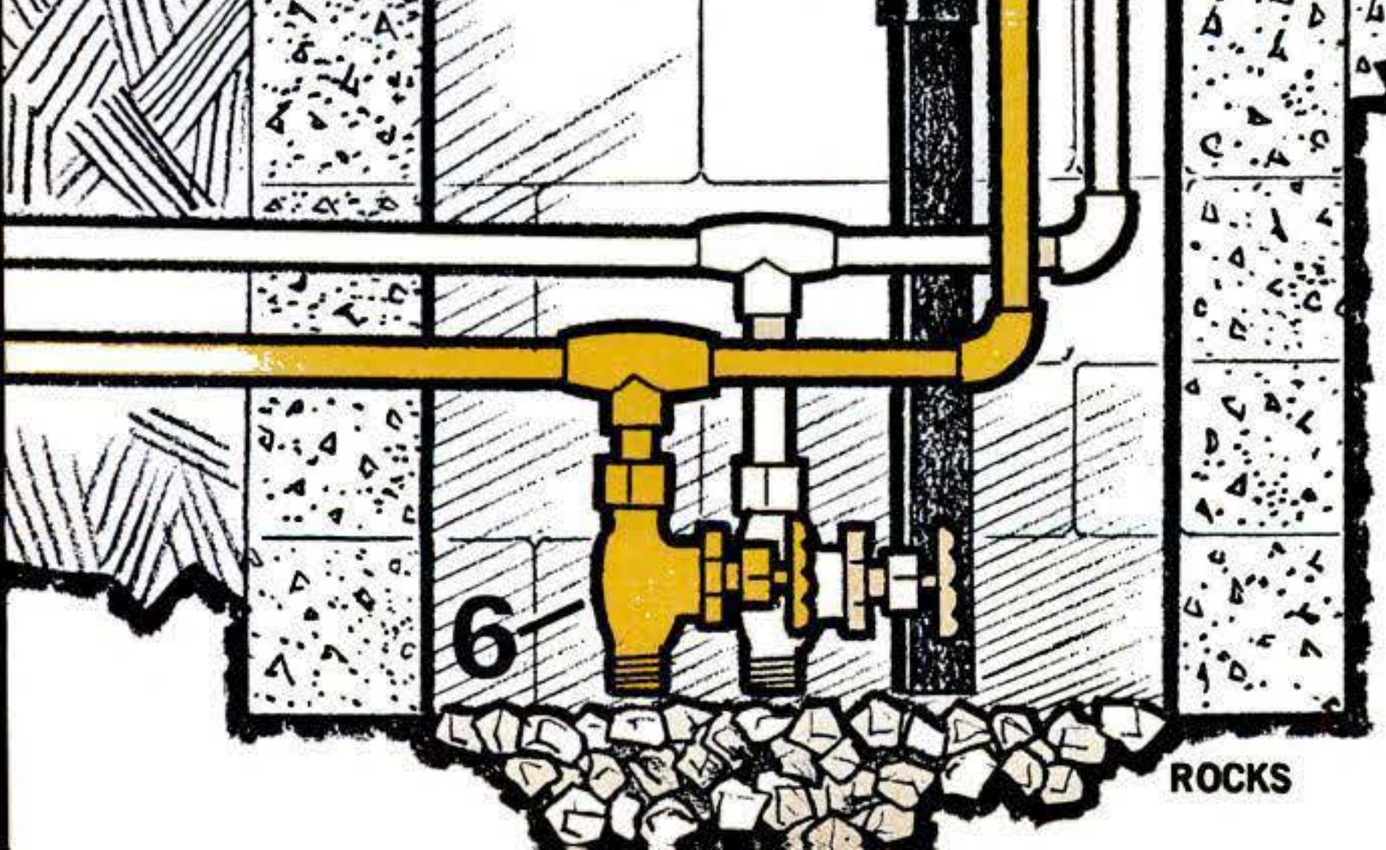
7 **Even if you can omit the valves** in step 6, you'll need this dry well to handle the outfall from sink drain. Dig a hole about four feet deep, three feet across. Put a foot of crushed rock in the bottom, line walls with concrete blocks. Place the hole right next to garage wall, and cover it.

8 **When plastic lines are inside** the garage and run up to mud sink location, your next job is to hook up to sink. This requires a conversion from plastic back to copper. The conversion starts with an adapter (Nibco's 4704), which cements to the plastic pipe at one end, has external threads at the other. Cement it in place, and lubricate its threads with Vaseline. This prepares it for the next fitting.

9 **Next comes a compression fitting.** The kind you want has ½" internal threads at one end, ¼" flare fitting at other. Turn threaded end onto the lubricated plastic fitting.

10 **Flexible ¼" copper tubing** runs from flare fitting to sink faucets. One end of the tubing must be flared to fit the fitting you've just installed. Do this with a flaring tool, a device that forces a metal cone into the end of the tubing, stretching it into a shape like a trumpet mouthpiece. You can buy or rent the tool. Tubing flared? Remove the nut from the flare fitting at the end of the plastic line, and slip it over the unflared end of the ¼" tubing. Slide it down to the flared end, screw it back in place on the fitting and tighten with a pair of adjustable wrenches.





11 **Last step on pressure-line installation** is to hook the ¼" tubing to the faucet. Remove brass nut, copper tubing ring, and rubber washer from the base of the faucet. Keeping them in order, slip them onto the copper tubing, and rethread onto the faucet.

12 **Waste pipe is usually made of ABS plastic,** not the CPVC used in pressure lines. Cementing procedure is similar. Use ABS solvent thinner on a rag to prime the joints, and use ABS solvent to do the welding. Wasteline hookup is simple. It starts with a slipjoint adapter (Nibco's #5801-7). One end of this threads onto the bottom of the sink outlet. Into the other end cement 1½" ABS pipe. Then run the waste line through the garage wall into the dry well. Use standard elbows to make turns. No trap is needed.

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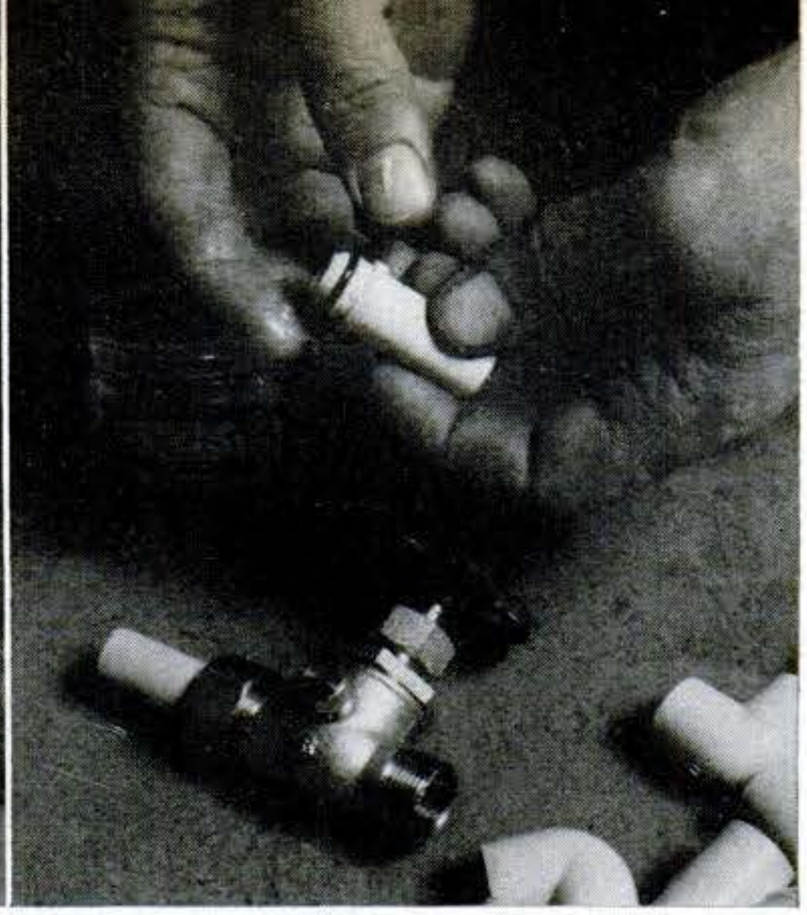
Standard commercial mud sink like this should cost around 40 to 50 dollars at a building-supply dealer, complete with faucets and a simple plug outlet.



Transition fitting looks like this. Use Vaseline on the O ring—not ordinary pipe dope. Don't ever tighten the nut when installing these plastic fittings.

A tubing cutter works fine on plastic pipe, but a hacksaw in a miter box is okay. Be sure to remove any burrs at the pipe end before solvent cementing.

Keep pipes clean by supporting them out of the trench when working outside. CPVC pipe comes in 10-foot lengths you hook together with inexpensive couplings.

tion: There's the hookup to existing lines, installation of valves, cutting through walls and laying lines underground, installation of drainage lines, even construction of a dry well. (Since a mud sink wouldn't be used year-round—it's mostly for washing garden vegetables and muddy boots—we provided for winter drainage and didn't bury our pipes below frost line. You could, of course, if you're running lines to a heated garage.)

Plumbing planning. A complete diagram of the project you plan is a big help. After studying our diagram and getting acquainted with the standard fittings used, you should have no trouble with your own diagram. Be sure to measure the exact distances your new lines will travel. Include all the fittings you'll need to tap existing lines, install valves and fixtures, and to turn any corners. Then use your diagram to make up a shopping list.

At the hardware store you can dry-fit your materials to assure correct size. Plumbing sizes are easy to understand once you know that they're listed by inside diameter. Pressure lines are usually ½″ or ¾″. Use the ¾″ stuff for main distribution lines, the ½″ size to supply individual fixtures. For our mud sink we used ½″ pipe.

From here on, your work moves faster, and it's more fun. A job the size of the mud-sink installation shouldn't take more than a couple of hours once you've done trenching and dry-well work. Let the finished job set an hour or two, then turn on the water to test for leaks. A leak at a threaded joint can be fixed by retightening; at a cemented joint, cut it out and replace it. PS

Overlapping cuts with a hole saw can make the hole you'll need for the drain line to pass through garage wall. Use carbide bit to cut into masonry walls.

Rented trenching machine quickly digs trench you'll need to bury pipes. A rig like this can dig 50 feet in an hour or two, under ideal conditions (no rock or roots).

Tunnel for pipes under a sidewalk by driving a length of 2″ iron pipe from the trench at one side. Pad driven end of the pipe with wood block to protect it.

After leak-testing plumbing run, go ahead and cover pipes with dirt. Note that CPVC can't rust underground, and is flexible enough to take long-radius curves.

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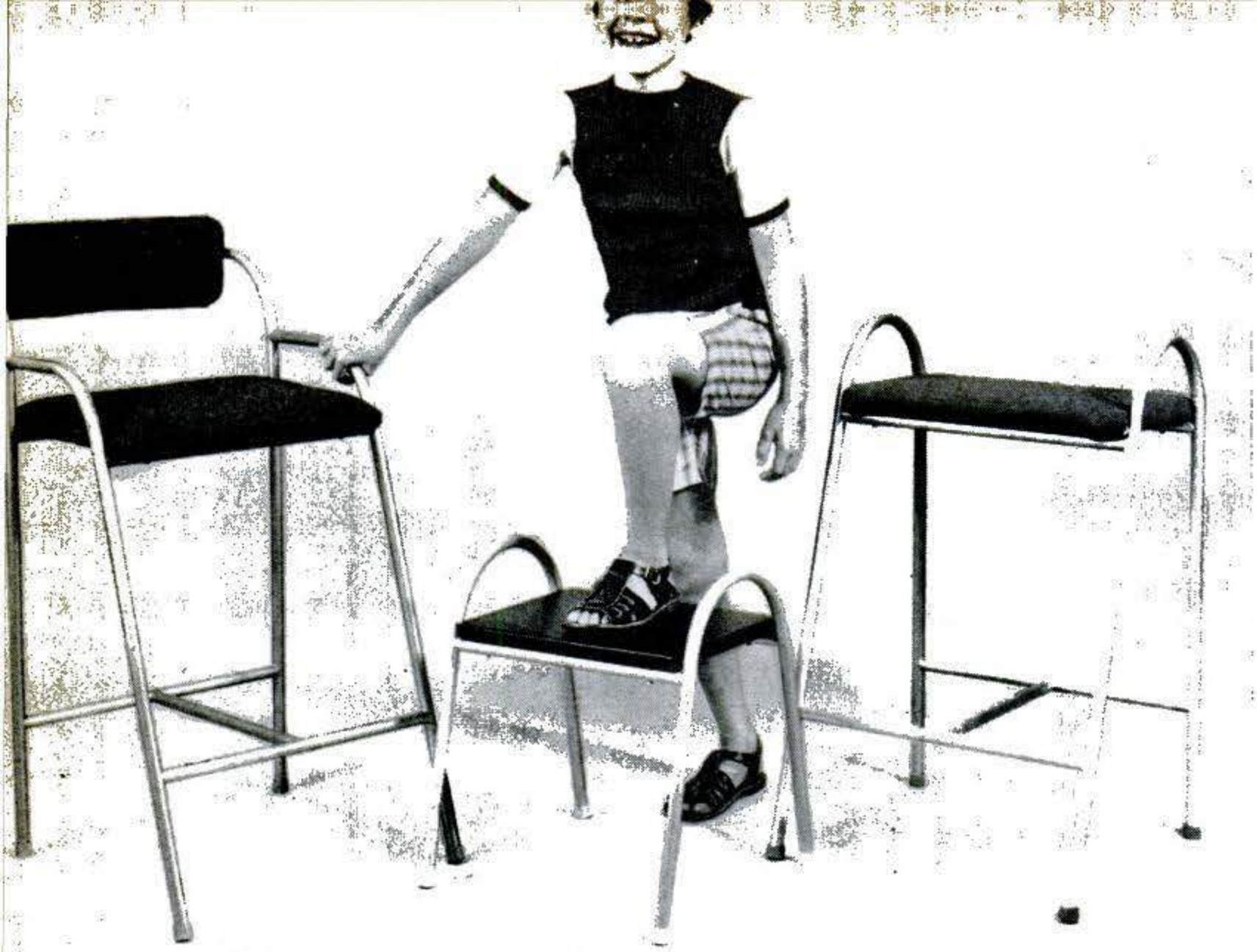


Thin-Wall Conduit Stools:

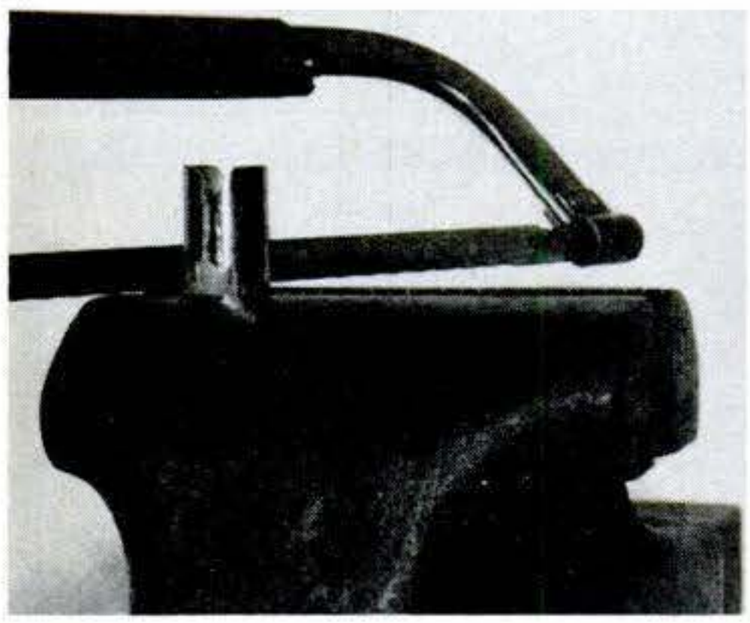
Bend them up yourself

They're easy to assemble with silver solder and a propane torch

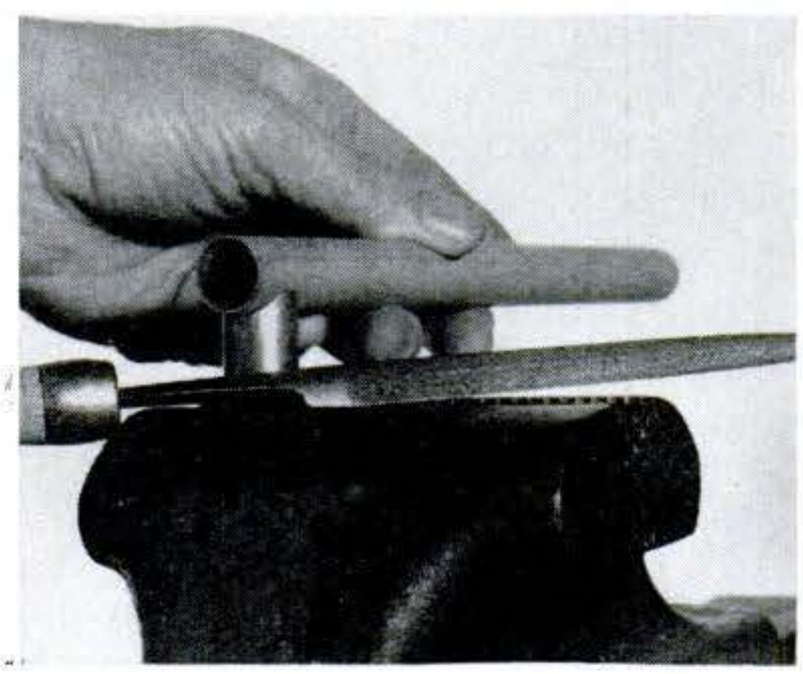
By R. S. HEDIN
DRAWINGS BY HANK TOMKALSKI

Electrician's hickey (conduit bender) bends thin-wall to 4½" radius without kinks. Get one where you get conduit, or try a rental shop. Note how it's lined up with "start" mark on conduit.

To make a bend past 90 degrees you'll have to twist the conduit to clear the hickey handle. Remove twist later, by clamping the bend in a vise and twisting the ends by hand until straight.



Neat butt joint starts with a ¼"-deep V groove sawed into conduit end. Follow up by removing all zinc plating near joint. If the zinc melts into your solder joint it will weaken the bond.



Enlarge the V groove with a half-round file, cutting radius to match the diameter of the conduit. A close fit between parts is vital for a neat, strong joint. Check joint for squareness.

Nearly everyone can use a stool or two around the house. At least one of the three shown here should fill a need in your home. The two high stools are real legsavers in the kitchen or workshop. The low one is a fine step stool or kid's TV seat. All three are easy and economical to make.

Frames are ordinary ½" thin-wall conduit with silver-soldered joints. Silver solder makes for sturdy joints, and you can use it with ordinary shop tools and techniques. Upholstered seats are simple, too; they give the stools a finished, professional look.

Get the conduit at a hardware store or an electrical-supply house. It comes in ten-foot lengths and costs very little–I paid around 80 cents a length.

You make the bends in the thin-wall with an electrician's hickey (conduit bender). Buy it where you get the conduit, or rent one.

The photos show you how to use the hickey. It produces bends with a 4½" radius–just right for the kind of work you'll be doing here. Though it's not designed to make bends past a right angle, a little improvisation adapts it to the job.

How to start. Make a 90-degree bend, then slip the hickey back along the bend and apply more pressure. Conduit bent past 90 degrees will have to pass by the hickey handle and so will be twisted slightly. To remove the twist, put the conduit in a vise at the bend, and pull ends until the frame lies flat on the floor.

Continued

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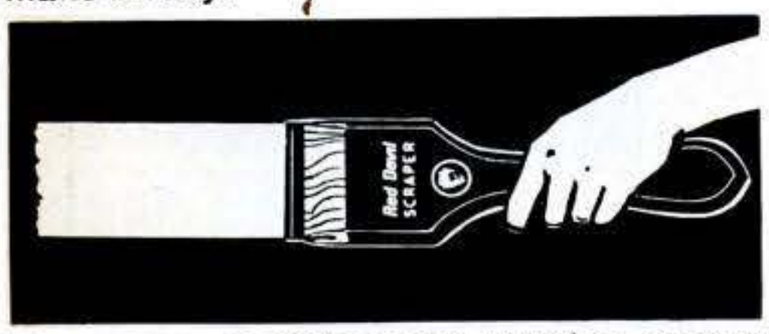

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Conduit cuts best with a pipe or tubing cutter, but a fine-toothed hacksaw works well. Compare bent side frames by placing one atop the other and bending until they match.

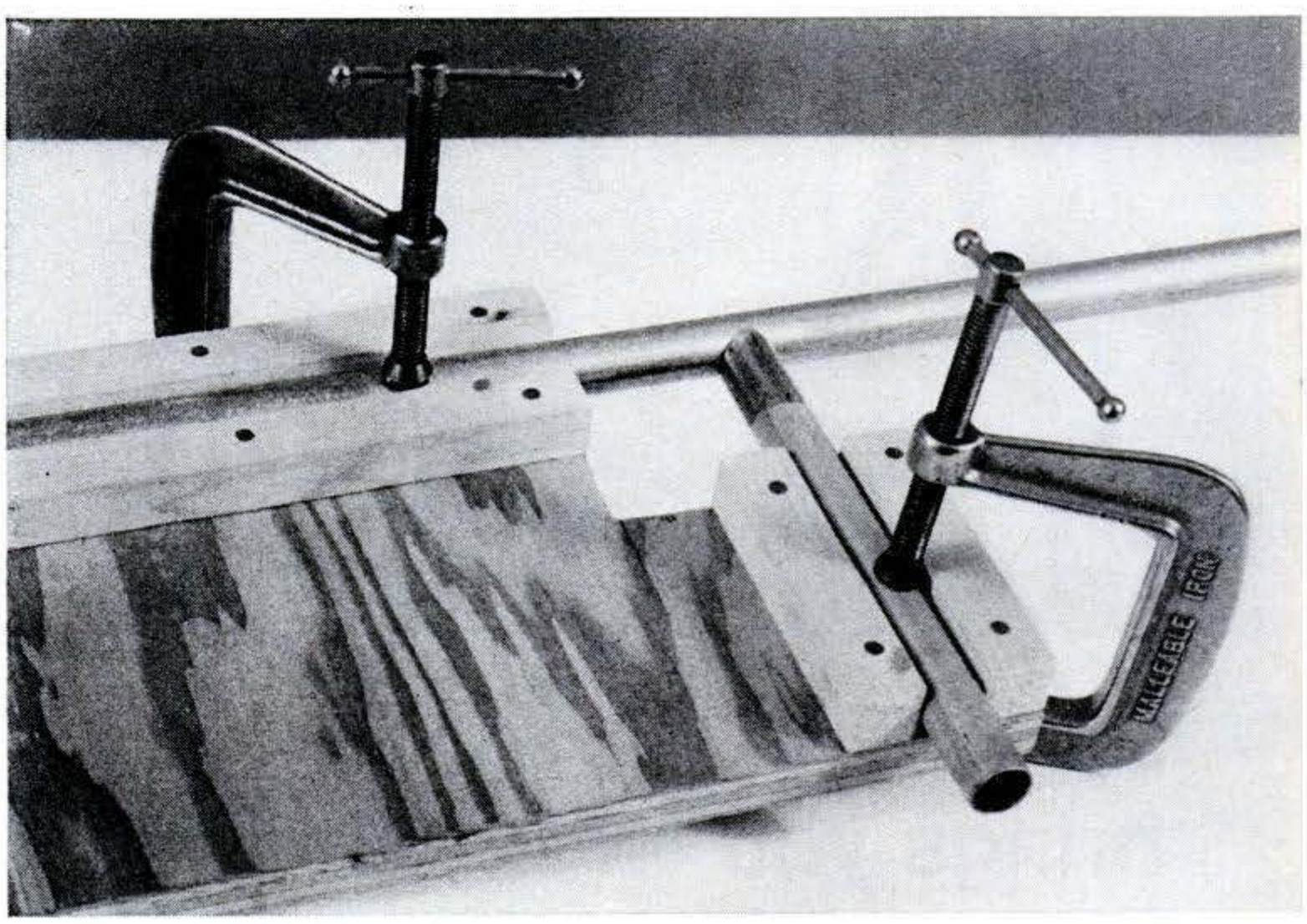
Stool rails are joined to the side frames with silver-soldered butt joints. If you've never tried silver solder, you're in for a treat. It's strong, easy to use, and melts around 1100 degrees. That's well within the range of an ordinary propane torch. Get an ounce of 1/16″ wire solder at a welding supply dealer. Get some flux for the job while you're there.

For neat, strong joints, the butts should be a tight fit. The photos on page 128 show you how to make a fast, neat butt.

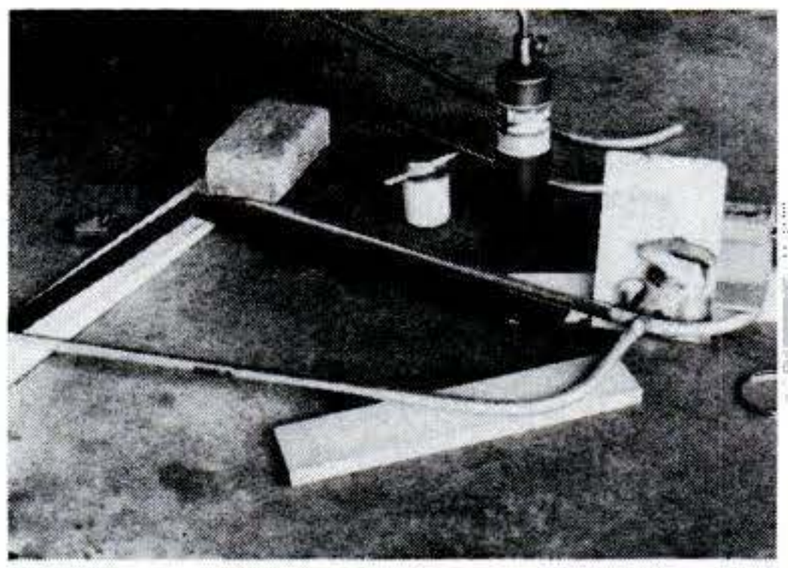
Silver soldering. Joints ready for solder? Apply the pasty white flux to all surfaces to be joined. Clamp the parts in position, then heat all around the joint with your torch. When the flux melts and turns clear, touch the solder to the joint. Continue heating until the solder melts and flows freely into the joint. Let heat in the work do the melting, not the torch itself.

Let cool, then remove the hardened flux and clean up the joint with warm water and a coarse scouring pad. Then sand the entire frame, spray on a coat of aerosol metal primer, and finish with an aerosol color of your choice.

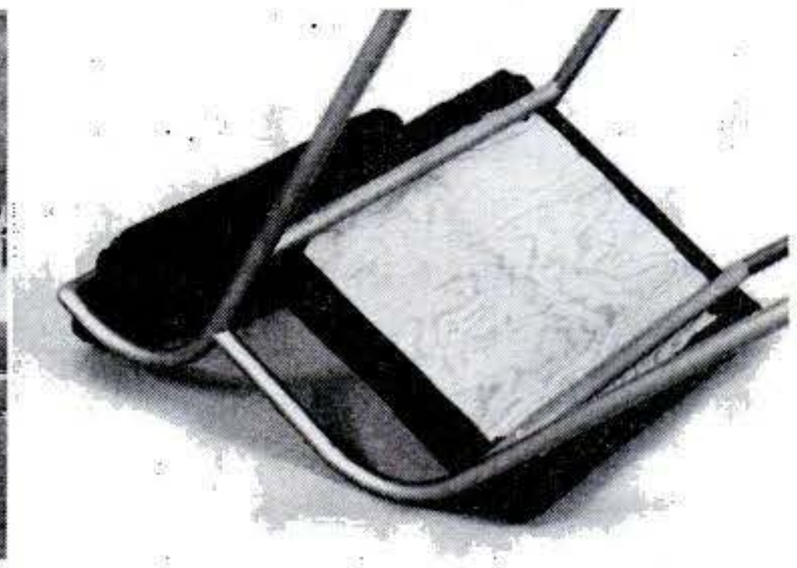
Upholstering the seats. This is easy–no needle-and-thread work is involved, just some simple stapling. Start with either 1″ or 2″ plastic foam for the cushions. Cut it flush with the sides of the wooden seat, and long enough to lap around the front and rear edges. Cut the upholstery material large enough to overlap the bottom about 1″ all the way around. Staple it evenly and tightly along each edge, then fold the front and rear flaps as if wrapping a package, and staple them in place. Use an extra piece of material to cover the staples on the back of the backrest. Fasten this piece down with decorative upholstery tacks. PS



Simple jig like this assures proper alignment of parts, leaves hands free for soldering. Tack strips of ¾″ pine to a plywood base. Align with a square.



Ordinary propane torch puts out all the heat you need to work with silver solder. Always use the proper flux for silver solder; without it, the solder tends to bead instead of flow.



Upholstered seats and backs are screwed to conduit frame. Use 1½″ roundhead screws for best appearance. Silver-solder washers to crosspiece that supports backrest, as shown in drawings.

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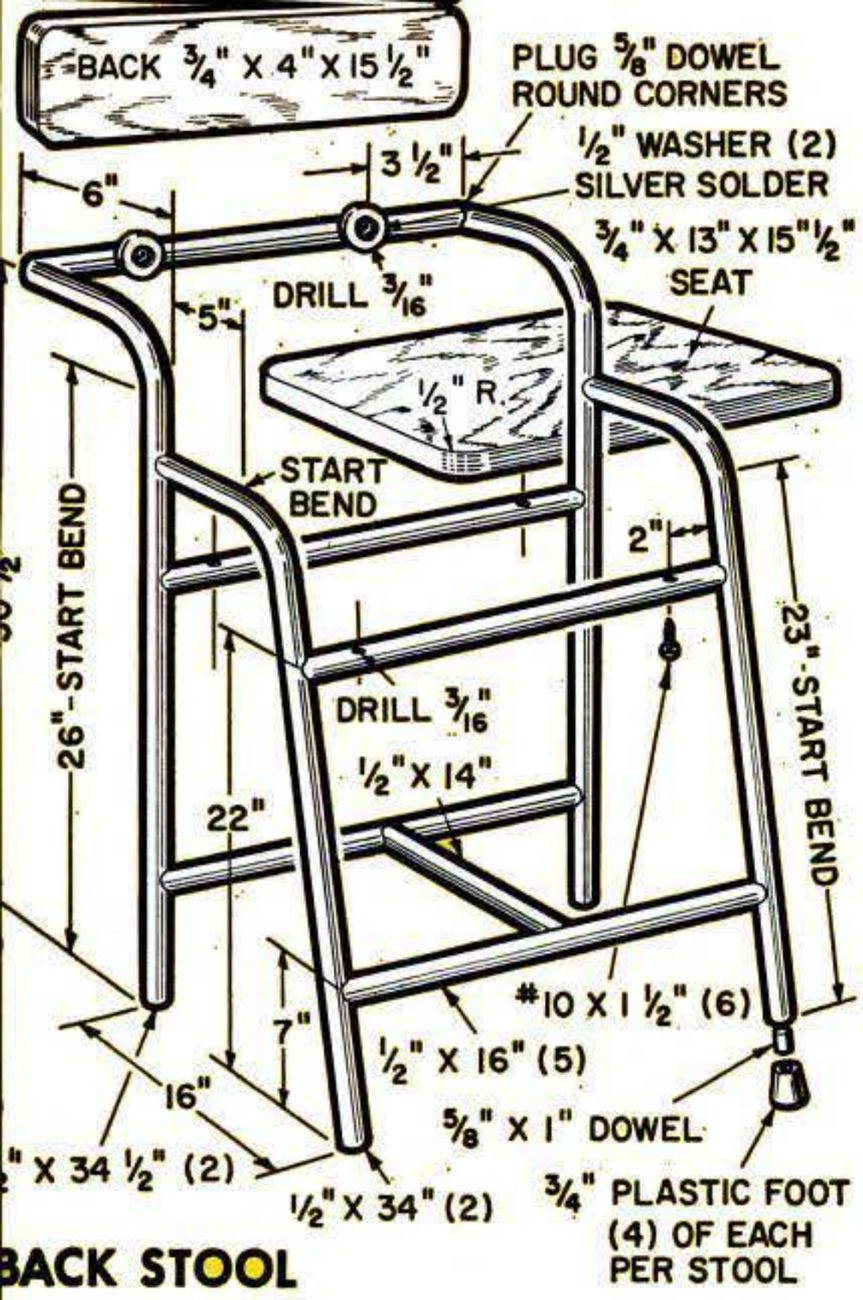
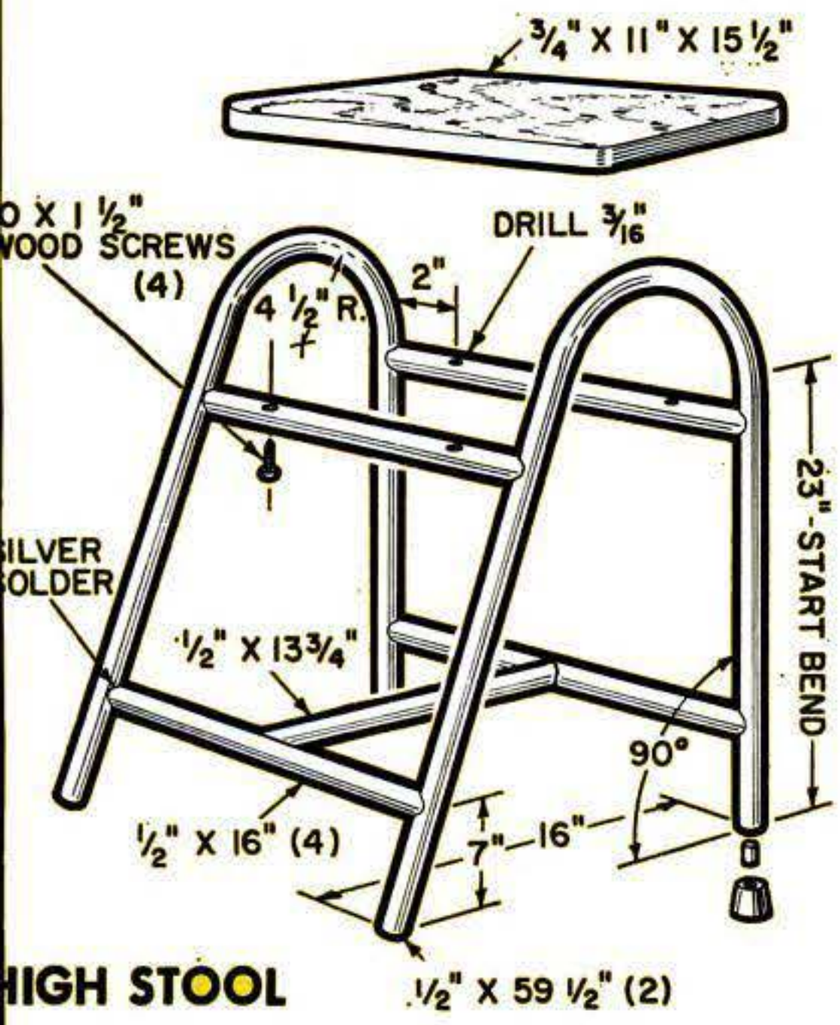
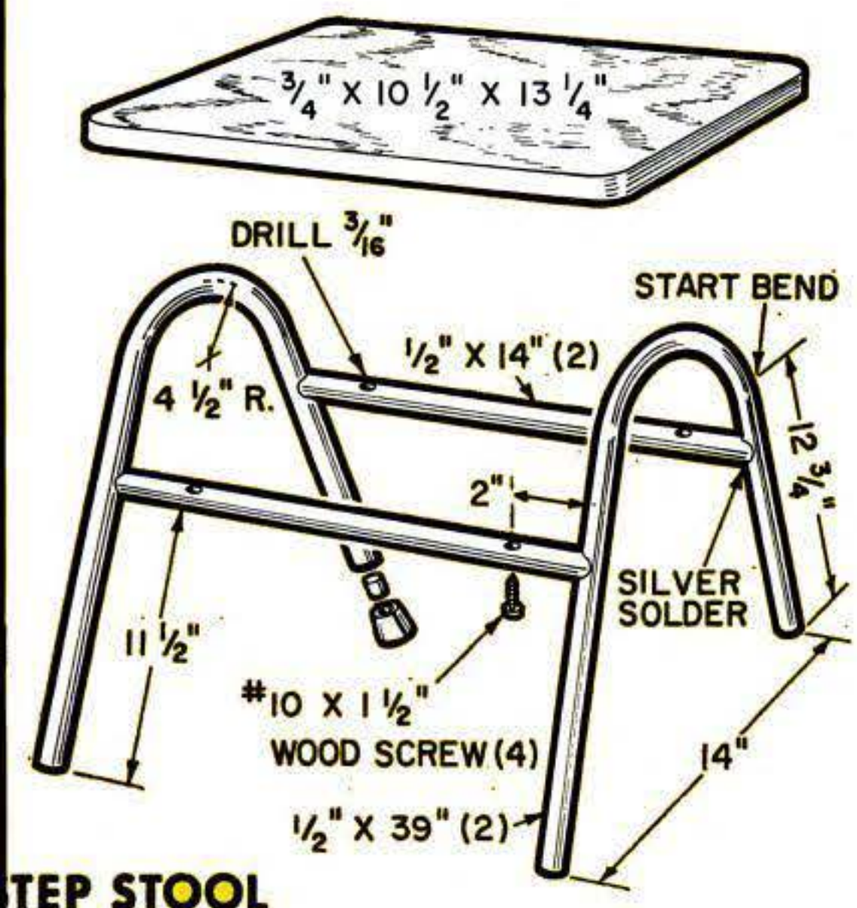


BACK STOOL



HIGH STOOL



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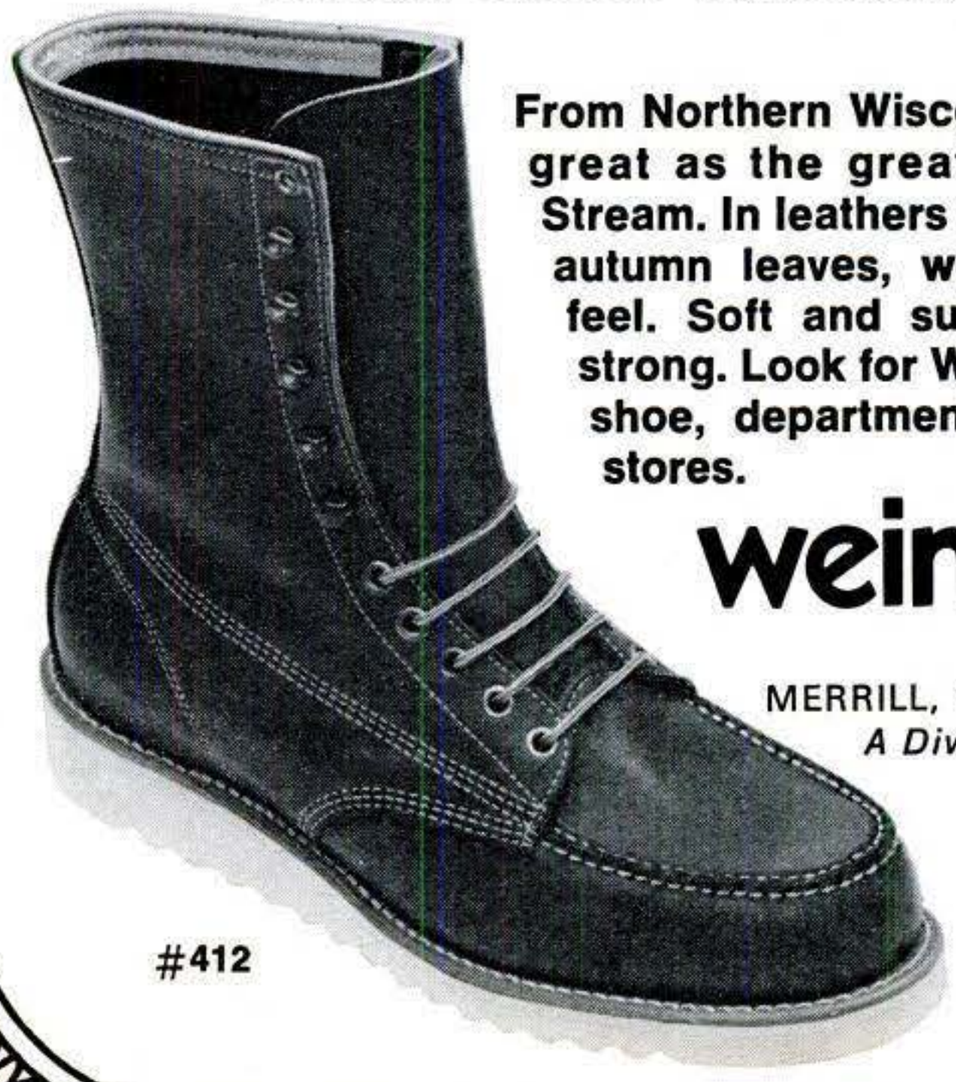

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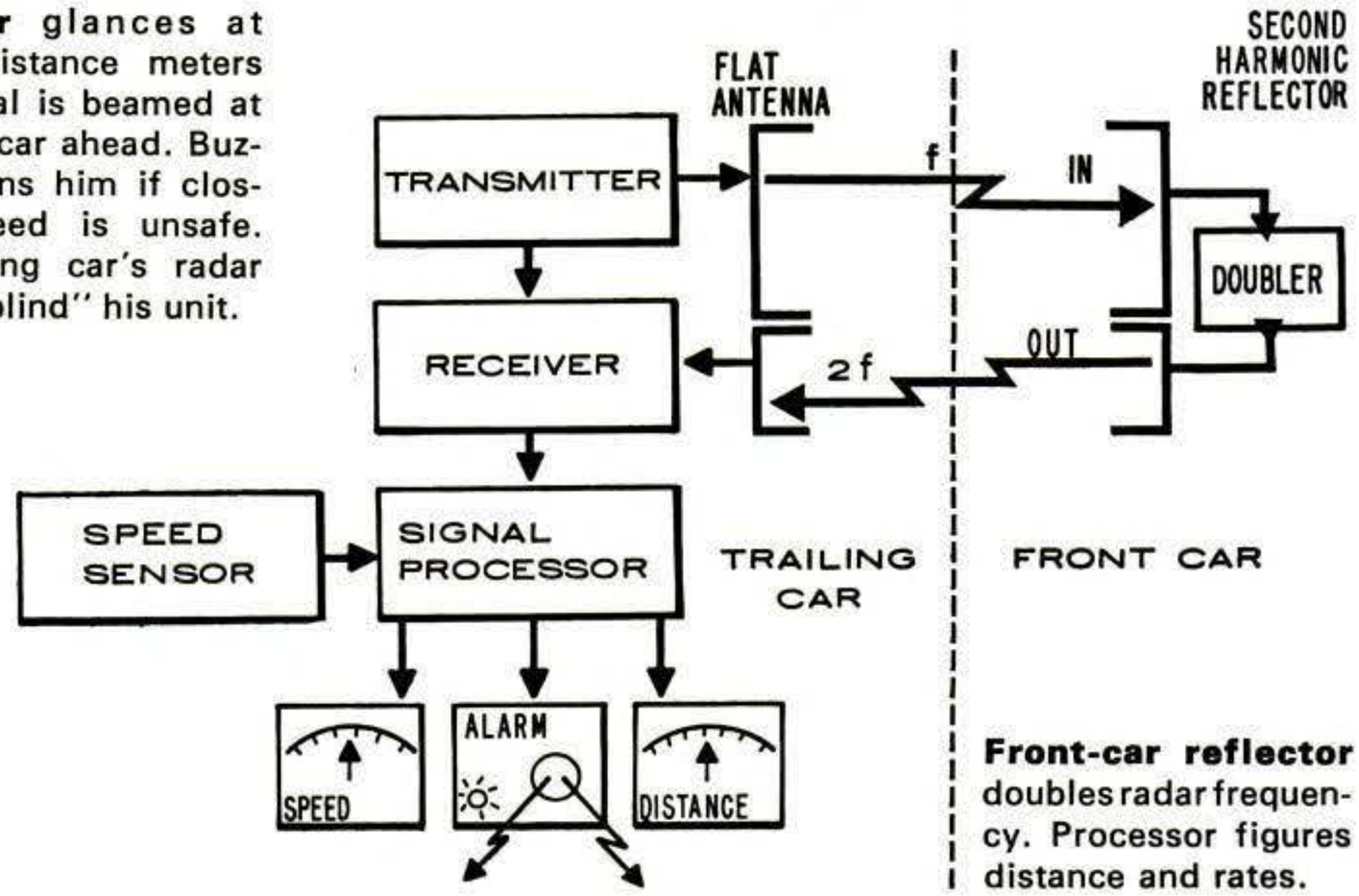

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On future cars, a transmitter/receiver could be concealed in the grillwork or behind a plastic front license plate. RCA's prototype is 17 by 8 by 2½ inches. As you drive, the transmitter beams a continuous 100-milliwatt, nine-GHz (billion-cycle) signal ahead of you. When this narrow beam strikes special passive reflectors on the rear of vehicles ahead, the frequency of the signal is doubled and reflected back to the radar unit.

Measuring the time required for the signal's round trip, the radar calculates the distance to the vehicle ahead. Alarms sound when the separation distance decreases below one car length for each 10 mph of speed of the radar-carrying vehicle.

Frequency-doubling is the key to RCA's system. Two arrays of 128 antennas–looking like rows of four-leaf-clover petals–are etched on the passive reflector's printed-circuit board. One array picks up the nine-GHz signal, a diode doubles it to 18 GHz, and the second antenna array radiates the signal back. Since highway signs, bridges, trees, and other objects can't double the nine-GHz signal, radar receivers aren't plagued with "ground clutter"–false targets normally encountered in highway radar systems.

RCA believes within five years the transmitter/receiver and special reflector could be mass-produced at $50-$100 per car. To make the system effective, $10 reflectors would be required by law for all cars.–*John Free*

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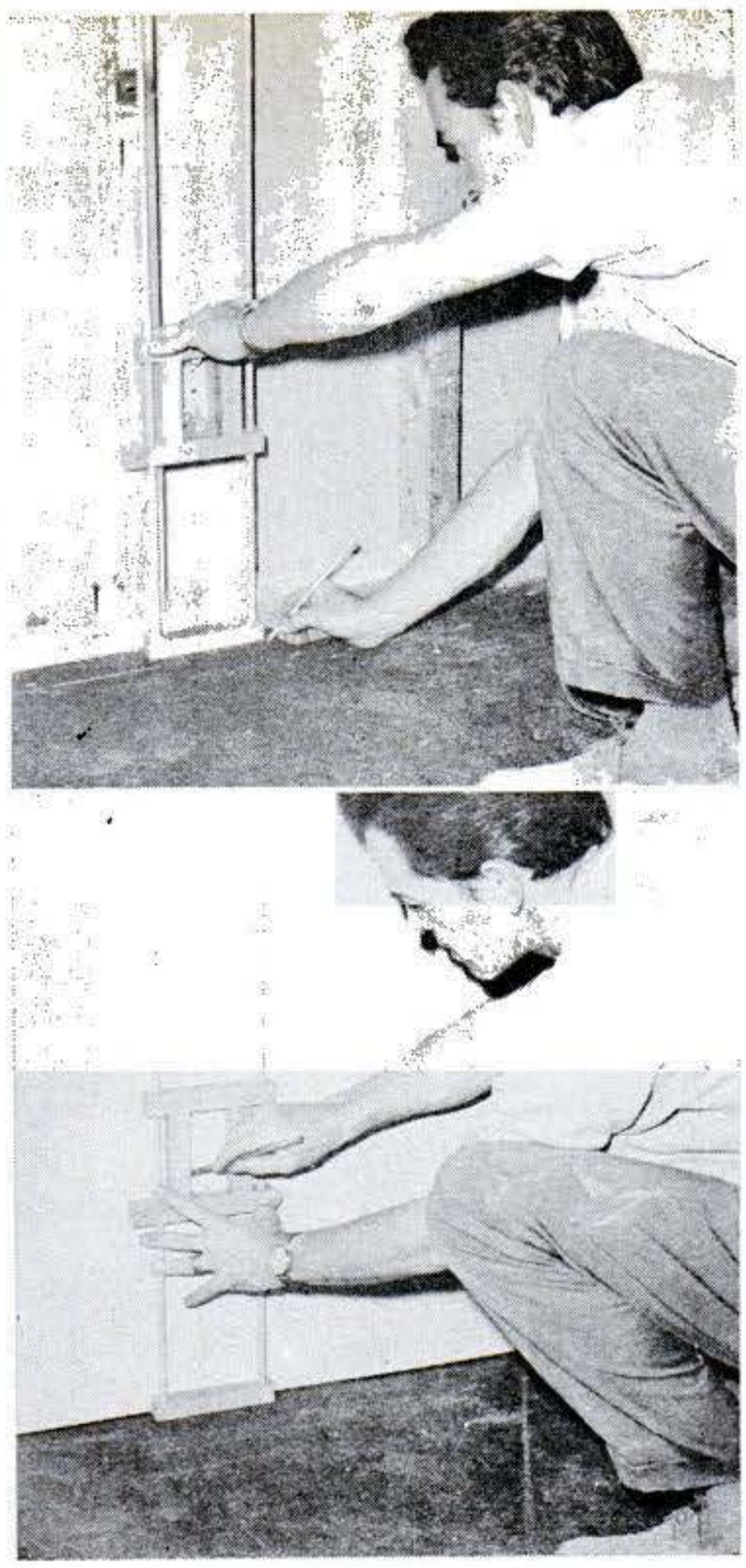
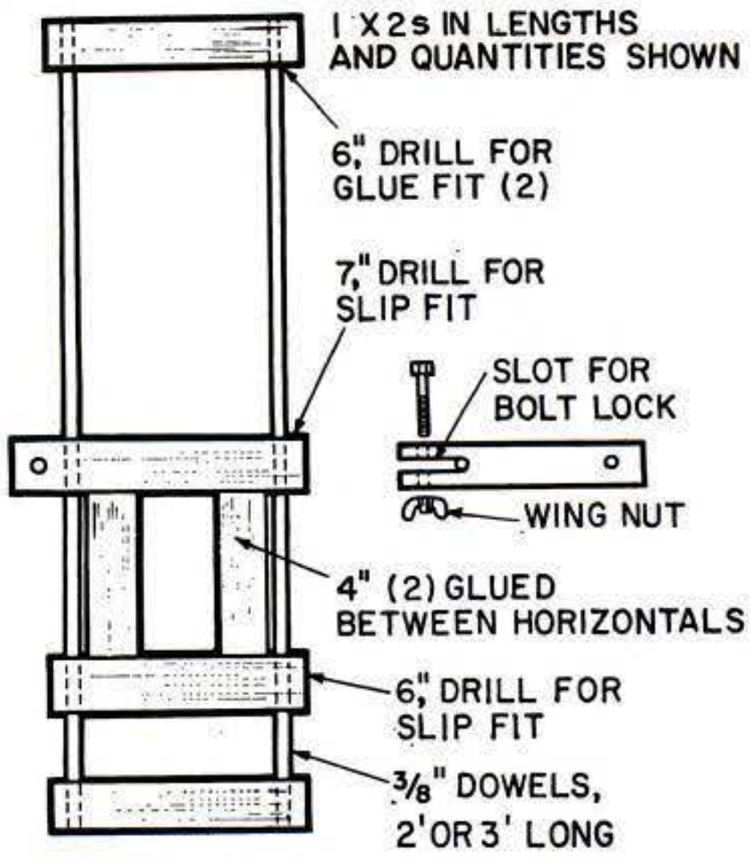


SHORT CUTS AND TIPS

FROM HERE AND THERE

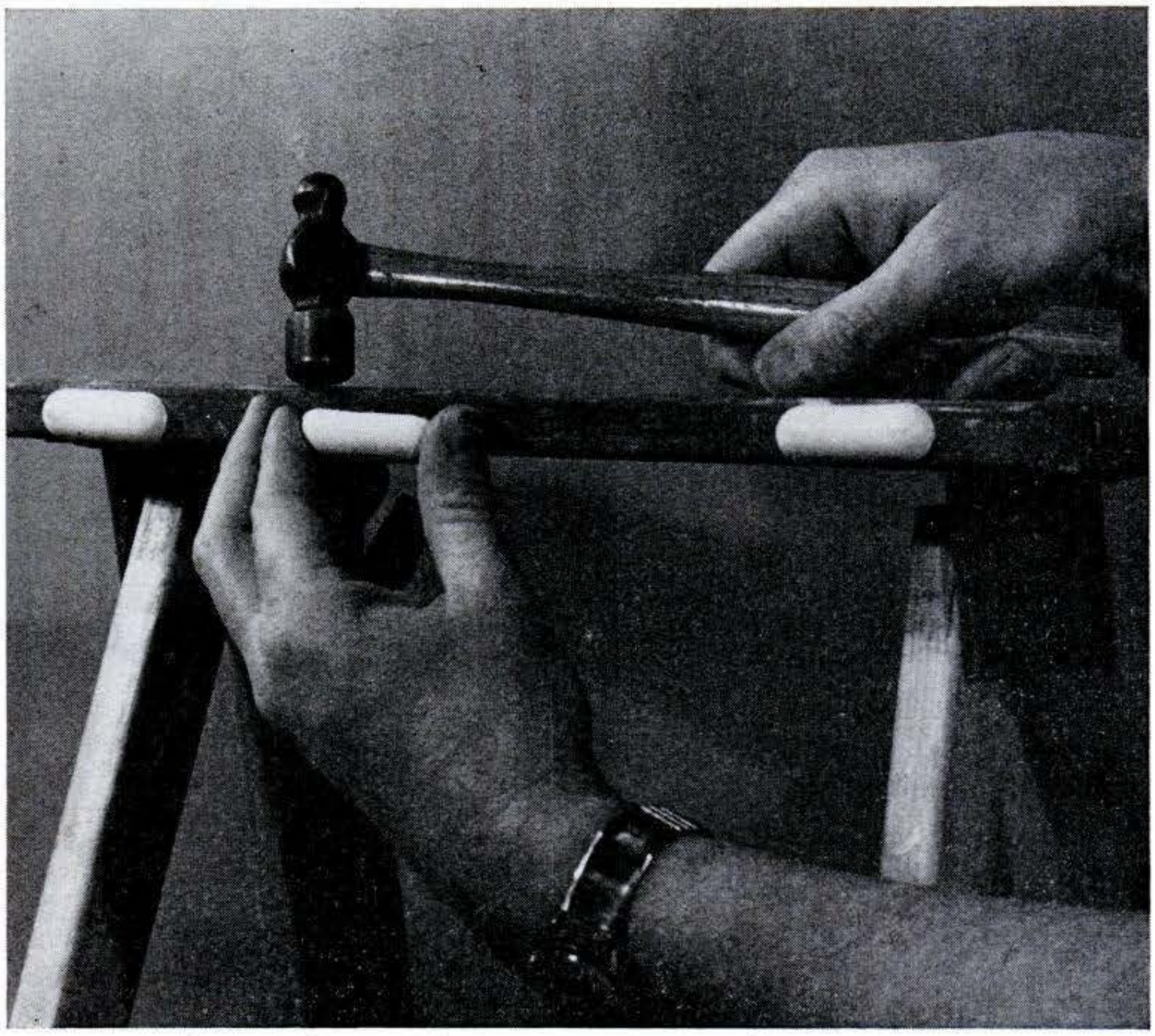


Adjustable outlet spotter

Here's a handy way to locate an outlet box when finishing a wall. Center the locator over the box and mark the floor at its base (top photo). Slide the frame up to proper height. When the wall is in place, return the locator to the marked position; trace the section to be removed. The hole will be perfectly aligned with the outlet.

ELDRED ADAMS, Fremont, Calif.

Bumper protectors for a wooden stepladder



Two or three toilet-seat bumpers fastened to the edge of a stepladder will prevent the marks that often result when the ladder leans against the wall. These rubber or plastic bumpers come equipped with nails for easy mounting and can be easily removed later, if necessary.

KEN PATTERSON, Regina, Sask.

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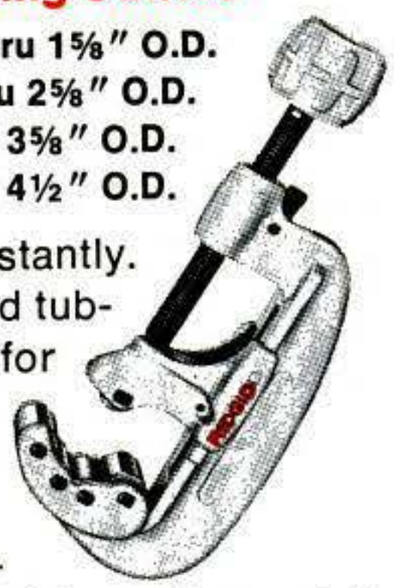

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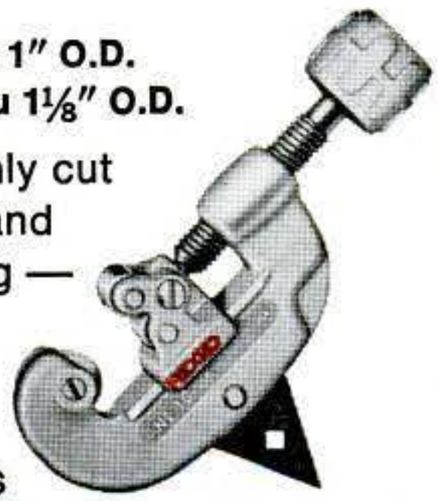

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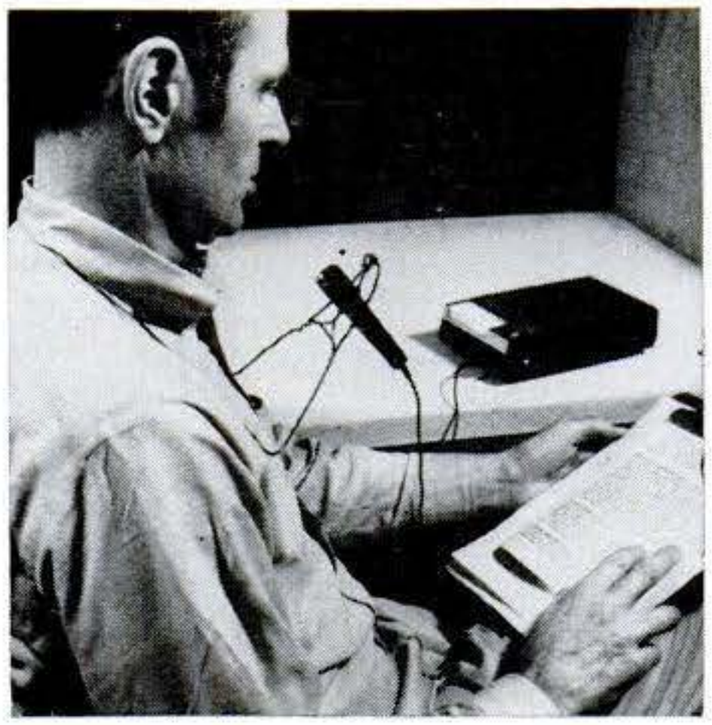
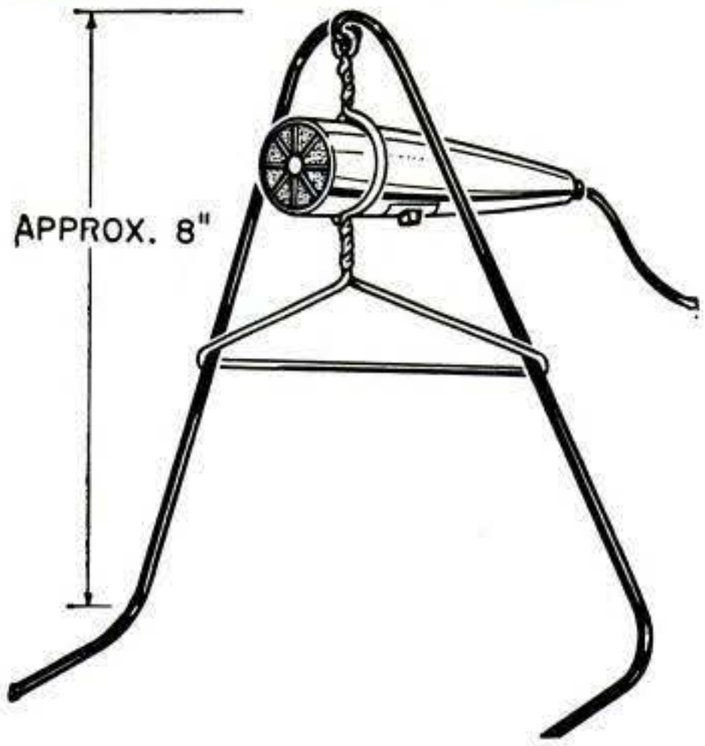
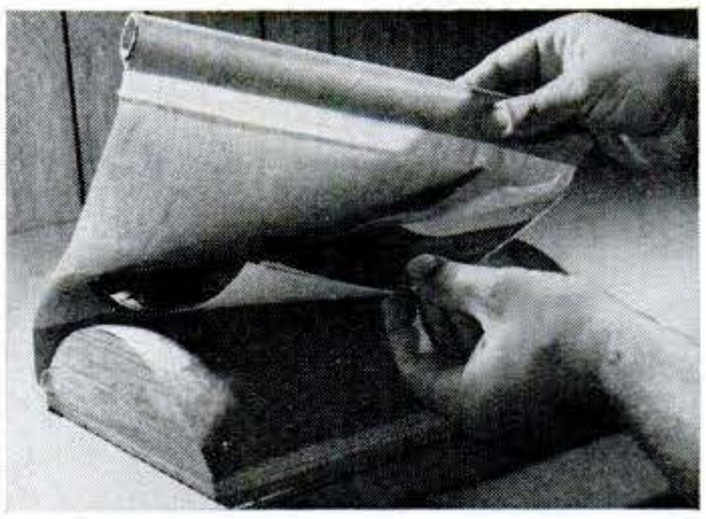
FROM HERE AND THERE





Microphone holder

A hand-held mike is not only awkward, it gives uneven tone and volume. To make this chest bracket, straighten a wire coat hanger, and bend it in the middle to fit around your neck. Then bend up each end so the mike will be held 8" from your chest. Twist the ends together, and suspend the mike on a rubber band twisted between loop and sidebars.



Press uncurls prints

A press that holds photo prints in a curve the reverse of their natural curl will straighten them in a day or so–without cracking the emulsion. Cut 1½"-by-3"-by-12½" ends to a 10"-dia. curve, glue them to a ½"-plywood base and top with sheet tin. Anchor one edge of heavy cloth to the press and hem pipe into the other.

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Taking Care of Your Car

By RAY HILL

Good hints others have used

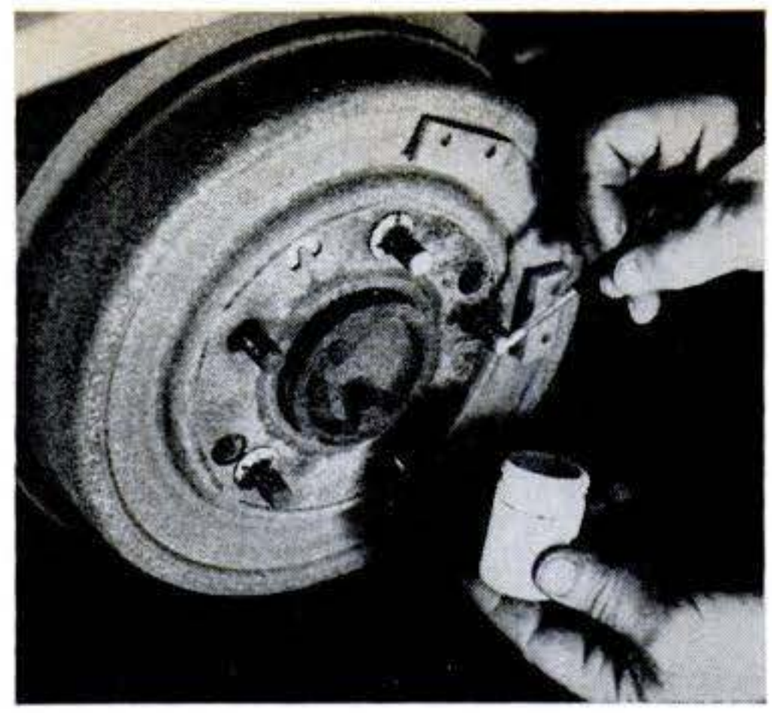
Got a car tip? We pay $25 for each one accepted. Send it to Car Care, Popular Science, 355 Lexington Ave., New York, N.Y. 10017. None are returnable.

Ignition switch won't turn while car's parked against curb

This can occur if your car has a combination steering-wheel lock and ignition switch on the steering column. Turning the steering wheel left and right while twisting the key relieves pressure on the switch, and allows it to turn.

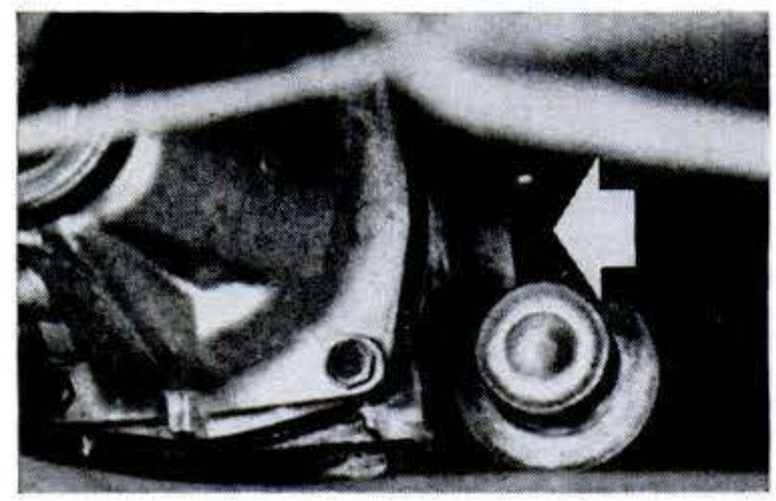
Installing new heater hoses the easy way

New heater hoses can be difficult to install because they're stiff. To make them pliable, place them in a pan of hot water for several minutes. Now slipping them over their fittings is easier, skinned knuckles less likely.



Paint studs for visibility

Whether you're rotating your tires, putting on new ones, or replacing a flat, you'll find that painting stud ends with white paint makes lining up studs with wheel holes easier. Light reflects off the whitened studs, speeds remounting.



Transmission shifting late?

If so, and your automatic transmission is vacuum controlled, the vacuum line running from the intake manifold to the transmission may have a cracked connector, either at the transmission or manifold. If the connector is cracked, replace it.

Rattling gasoline tank

If you can push the tank up and down when it's nearly empty—and the bolts and straps that hold the tank on are tight—more insulation padding is needed between the fuel tank and the body panel. Auto parts stores or body shops have it.

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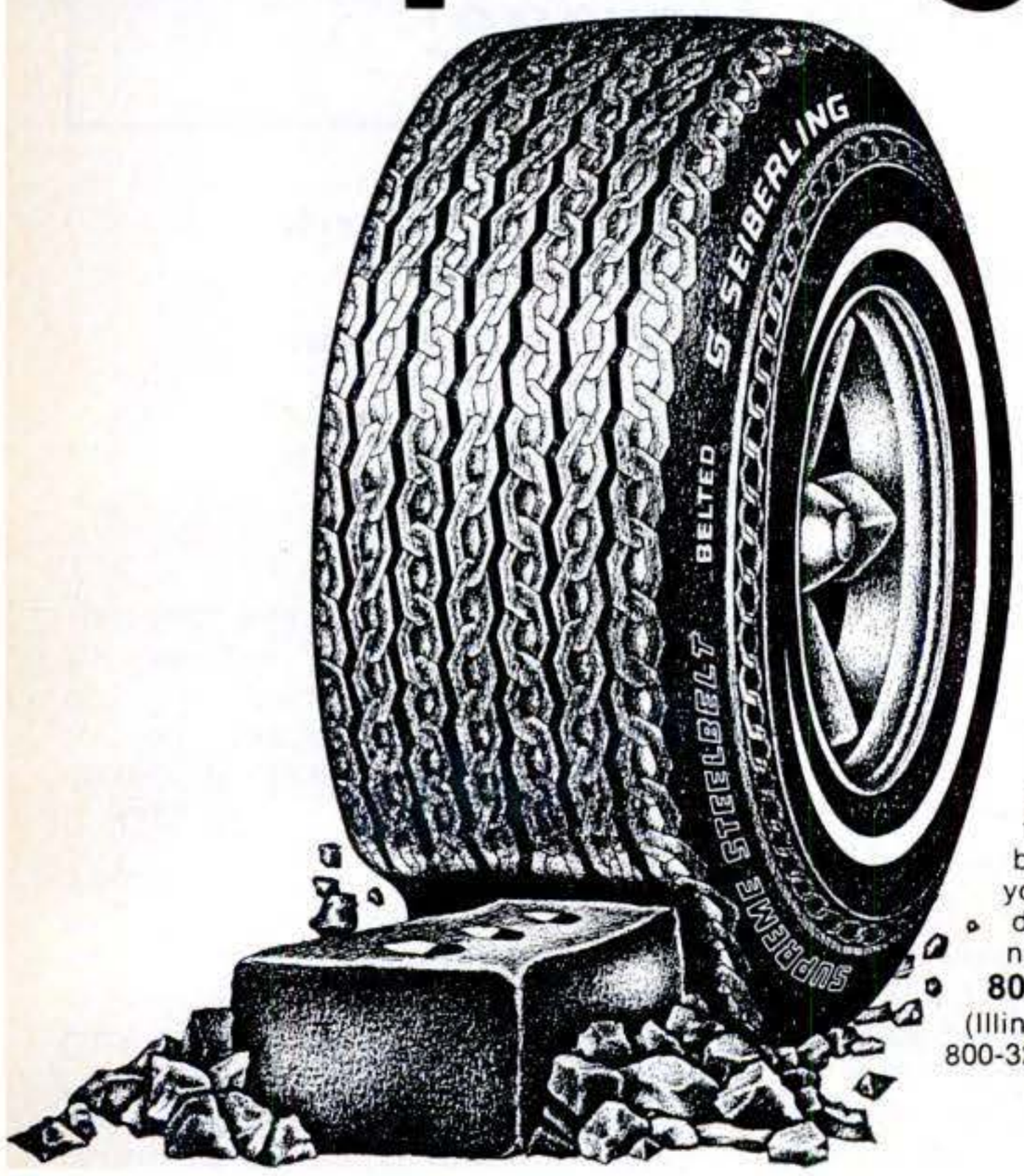
Bump and grind.



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Eyeing the Stars from Space

[Continued from page 78]

Bag of tricks. Rolling over on command, like a well-trained pet dog, is the most elementary of Copernicus' tricks. By so doing, it takes a bearing on the sun—an initial step in star-hunting. Controls slew the satellite to point its roll axis at the sun, and it rolls again. This time, star sensors lock on to preselected "guide stars" giving points of reference, from which to zero in on a desired target.

When the wanted star's light enters the big aluminum telescope, a final automatic "fine-pointing" system takes over. As the focused beam of starlight passes through a slit on the way to a spectrometer, the slit's beveled edges reflect portions of the light to photomultiplier tubes, which generate "error signals" if the beam is slightly off center. The signals elicit delicate maneuvers to make the beam strike the slit head-on, and to keep it that way.

Inside the big telescope's spectrometer, a ruled grating spreads the starlight into a rainbow-like spectrum, which can reveal the star's composition and much else about it. Photo cells on movable carriages scan the spectrum, to analyze its intensity at various wavelengths. The information is radioed to earth in the form of a stream of numbers that bare the star's secrets.

What's next? Even as crewless Copernicus orbits the skies, the first manned stellar observatory in space is going into action. One of our Skylab space station's many experiments will test a small ultraviolet stellar telescope, mounted on an airlock in the side of the orbital-workshop section, with a 35mm camera to photograph spectra of the stars. The instrument is distinct from an elaborate solar observatory that forms a major part of Skylab, and occupies a whole separate section of the space station.

But NASA's most ambitious plans for stellar astronomy from space envision an unmanned orbiting observatory whose enormous 20,000-pound telescope would have a 10-foot-diameter mirror surpassing in size even Mt. Wilson's famed 100-incher. Currently the tentative scheme is to launch this Large Space Telescope, as it's conservatively called, from the Space Shuttle in the early 1980s. It would be able to see all the way to the edge of the universe. In addition to observing the spectra of faint stars, it would be equipped to make high-resolution photographs of astronomical objects, from nearby planets to distant nebulas. PS

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Canoe Camping

[*Continued from page 111*]

you still don't need much. The canoe will be your biggest investment. Once you own it, you're ready to paddle toward fun any weekend. Here's what you'll need—and need to know.

For shelter, a module or a lightweight nylon tent works well [PS, Aug, '72]. We used both on our trip. Sleeping bag? Down is the only way to go—for summer or winter camping. A down bag can be compressed very small for packing, left compressed for a long time, and upon release will quickly come back to its original thickness.

I always use a three-pound down bag. On warm summer nights I peel down to my birthday suit and leave the bag unzipped after I get inside. On cold winter nights I use a liner.

What about clothing? If it's summer and you don't have a tan, you'll want to wear a long-sleeve shirt and pants. For footwear, canvas sneakers fill the bill admirably. They're comfortable and dry out fast when they're wet.

Don't make the mistake of paddling all day with your shoes off. Sunburned feet are painful and can ruin a canoe trip. A hat is a must. A raincoat, light jacket (in case the weather turns cold) and a pair of sunglasses should also be included. To guard against hand blisters from prolonged contact with the paddle, take along a pair of gloves.

You can eat like a king while you're on the water. Everything from applesauce to chicken is available in the new freeze-dried and lightweight foods. If your local grocery or sporting goods store doesn't stock them, write to the makers at the end of this article for complete catalogues.

To cook the food in areas where dry driftwood isn't available or fires aren't permitted, you'll need a small stove. We took along a Bleuet (available in sporting goods stores). It weighs less than three pounds, and comes complete with a windscreen. You'll need water, of course, to drink and for meal preparation. If you don't pack enough to last the entire trip, boil river water for at least 10 minutes to purify. *Never* drink water from a river without boiling or using halazone tablets to purify it.

The canoe. Because it's light, cartops conveniently, can be paddled easily by one person for long periods of time, and can be used in very shallow water—the canoe is ideal for river travel. Prices run from $215 for a 10½-foot fiberglass Old Town canoe to $255 for Grumman's popular 17 footer. The size you buy will depend primarily on the amount of

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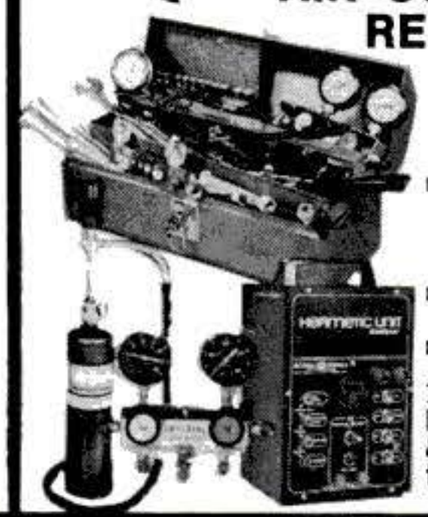

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Canoe Camping

[*Continued*]

people and gear you intend to put in it.

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Canoe camping is about the most pleasant way to spend a few days that I can think of. It's hard to describe the sense of peace and contentment you get from floating down the river all day, then pitching camp in some isolated spot at night.

I remember particularly the fourth night out. We were 100 miles down the Green from our starting point. The following day we would paddle down the river another 30 miles to meet the Colorado. We had camped not far from a big, flat rock that jutted out from shore.

Sunset on the cliffs. After a hearty supper of beef stew and apple pie, photographer John Flannery and I walked out on the rock to make plans for the next day. As the sun slipped below the horizon the huge sandstone cliffs around us became dark red, fading into giant black silhouettes as night engulfed us. We sat there, talking, not wanting to leave, until about 11 o'clock. Then we walked back to camp under a clear moonlit sky. The other two members of our party had already doused the campfire and were asleep.

The next morning, we rose early, loaded our gear into the canoes, and took off on the last 30-mile leg. We reached the Colorado about four o'clock that afternoon and set up camp near where the two rivers flow together. Around five we heard the faint sound of a boat engine in the distance—a sound we hadn't heard in almost a week. It seemed strangely intrusive—unnatural in that tranquil setting.

A few minutes later, the jetboat that Tex had sent for us arrived. Next morning we loaded our canoes in it, then crawled in it ourselves to begin the high-speed trip 70 miles back up the Colorado to Moab, Utah, and civilization. PS

Where to get catalogues. Tents, sleeping bags, and clothes: L.L. Bean, Freeport, Maine 04032; Eddie Bauer, 1737 Airport Way South, Box 3700 Seattle, Wash. 98124. Camp foods: Smilie Co., 575 Howard St., San Francisco, Calif. 941051; Stow-A-Way Products, 103 Ripley Rd., Cohasset, Mass. 02025. Canoes: Grumman Boats, Marathon, N.Y. 11714; Old Town Canoe, Old Town, Maine 04468.

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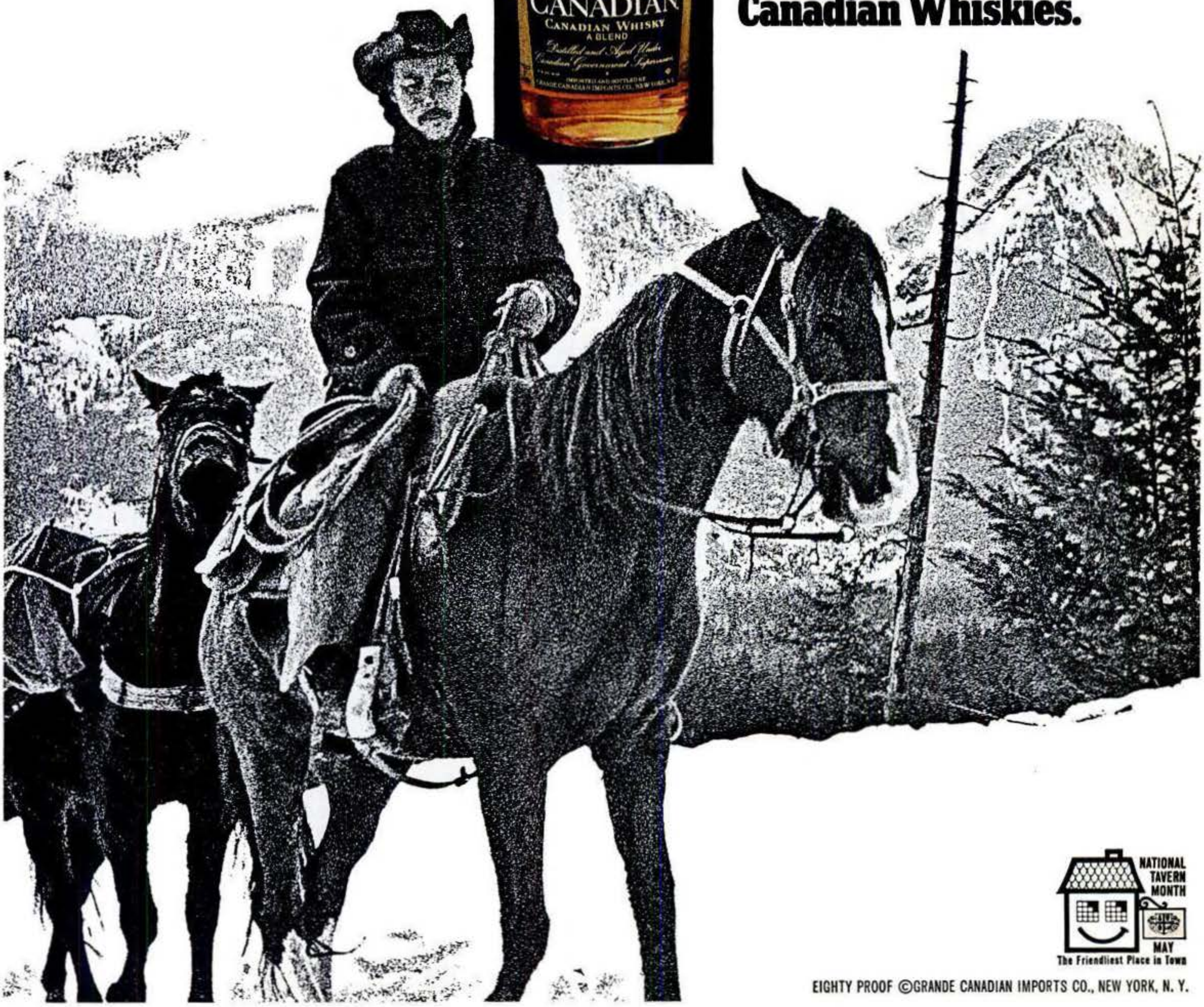

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"Cleared $110 last Saturday."—R. M. Davis, St. Louis, Mo.
"I hit $125 in one week sparetime!"—V. Tizio, Brooklyn, N.Y.

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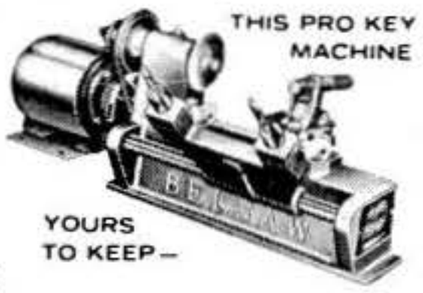

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Address _____
City _____ State _____ Zip _____
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PS Guide to Science and Technology Attractions

[Continued from page 109]

160. **Mich.:** Dearborn — Henry Ford Museum, Greenfield Village. Closed Christmas, Thnks., New Year. $2.25; child, $1.
161. **Mich.:** Flint — Alfred P. Sloan Jr. Museum, 1221 E. Kearsley. Closed Mon. 50¢; child, 25¢, 10¢.
162. **Mich.:** Hickory Corners — Gilmore Car Museum, Rte. 1. Open mid-June-mid-Sept. Sun. 1 pm-5 pm. $1.50; child, 75¢.
163. **Mich.:** Holland — Poll Museum, U.S. 31 & New Holland St. Open May-Oct., closed Sun. 50¢; child, 25¢.
164. **Minn.:** Rochester — Old Vehicle Museum. 90¢; child, 25¢.
165. **Minn.:** Two Harbors — Lake County Hist. and RR Museum, Depot Bldg. Open June 1-Sept. 30. Donation.
166. **Mo.:** Camdenton—Kelsey's Antique Cars, Closed in bad weather. $1; child, 30¢.
167. **Mo.:** St. Louis — Nat'l. Museum of Transport, 3015 Barrett Sta. Rd. $1.50; 75¢.
168. **Nev.:** Reno — Harrah's Automobile Collection. $2.50; child, $1.
169. **N. H.:** Meredith — Meredith Auto Museum, Rte. 3. Open June 25-Labor Day. 90¢; child, 50¢.
170. **N. Y.:** Ausable Chasm — Ausable Chasm Antique Auto Museum. Open daily mid-June - mid-Sept.; weekends, May-mid-June, mid-Sept. - mid-Oct. $1; child, 50¢.
171. **N. Y.:** Bridgewater — Upstate Auto Museum. May 27-Oct. 31. 75¢; child, 50¢.
172. **N. Y.:** Cooperstown — The Farmers' Museum, Lake Rd. Closed Mon. in winter; Thanksgiving, Christmas, New Year. $1.75; child, 40¢.
173. **N. Y.:** Hudson — Amer. Museum of Fire Fighting, Harry Howard Ave. Donation.
174. **N. Y.:** Southampton — Long Island Automotive Museum, Rte. 27. Daily, June 1-Sept. 15; weekends late May & Oct. $1.50; child, 75¢.
175. **N. Y.:** Stony Brook — Suffolk Museum and Carriage House. C.H. closed Nov. 1-Apr. 1; both closed Thanksgiving, Christmas, New Year. $1.75; child, 75¢.
176. **N. C.:** New Bern — Firemen's Museum. Closed natl. hols. 50¢; child, 25¢.
177. **Ohio:** Cayahoga Falls — Railways of America, 3656 Akron-Cleveland Rd. 85¢.
178. **Ohio:** Cleveland — Auto-Aviation Museum, 10825 East Blvd. Closed Mon. 75¢; child, 35¢.
179. **Ohio:** Conneaut—Conneaut Railroad Museum, Depot St. Open Memorial Day-Labor Day. Free.
180. **Ohio:** Dayton—Carillon Park Early Trans. Museum, 2001 S. Patterson Blvd. Open May 1-Oct. 31, except Mon. Free.
181. **Okla.:** Muskogee — Horseless Carriages, 2215 W. Shawnee. Closed Thanksgiving, Christmas, New Year. $1.50; child, $1.
182. **Ore.:** Banks — Railway Museum.*
183. **Ore.:** The Dalles — Fort Dalles Museum. Closed Mon., May-Oct.; closed Mon., Tues., Oct.-May. Free.
184. **Pa.:** Intercourse — Hex Barn Wagonland. 50¢; child, 25¢.
185. **Pa.:** Harrisburg — Automobilorama, Exit 17 Pa. Tpk. $2; child, $1.
186. **Pa.:** Huntingdon — Swigart Museum, Rte. 22 East. Open daily, June, July, Aug.; weekends May, Sept., Oct. $1.50; 75¢.
187. **S. C.:** Santee — Wings and Wheels. Open daily. $2.20; child, $1.10.
188. **S. D.:** Murdo — Pioneer Auto Museum, junction I-90, U.S. 83. Open Apr.-Nov. $1.25; child, 25¢.
189. **S. D.:** Rapid City — Horseless Carriage Museum, Keystone Rte. Open May 1-Nov. 1. $1.50; child, 40¢.
190. **Tenn.:** Chattanooga — Tenn. Valley RR Museum, 2242 N. Chamberlain Ave. Open Sun. only. $1; child, 50¢.
191. **Tex.:** Cresson — Pate Museum of Transp. Hwy. 377. Closed Mon. Free.
192. **Tex.:** Dallas — Age of Steam RR Museum, Fair Park. Closed weekdays Sept. 1-June 1. $1; child, 50¢.
193. **Tex.:** Weatherford — Texas Railroad Museum, E. Ft. Worth St.*
194. **Tex.:** Houston — Classic Car Showcase, 3009 S. Post Oak Rd. $1.50; child, 50¢.
195. **Utah:** Corinne — Railroad Museum.*
196. **Va.:** Luray — Car and Carriage Caravan of Luray Caverns.*
197. **Va.:** Roanoke—Transportation Museum.*
198. **Wash.:** North Bend — Puget Sound RR and Museum.*
199. **Wash.:** Seattle — Hall of Fire Engines, Seattle Center. Closed 2nd week Oct. to April. 50¢; child, 25¢.
200. **W. Va.:** Princeton — Oakwood Museum.*
201. **Wisc.:** East Troy — Trolley Museum. Closed weekdays, Labor Day to Memorial Day. $1.50; child, $1.
202. **Wisc.:** Lake Tomahawk — Sunflower Auto Museum.*
203. **Wisc.:** Oregon — Bermans Auto Museum, Hwy MM. $1; under 10, free.
204. **Wisc.:** Port Washington—Brooke Stevens Auto Mus., 10325 N. Port Wash. Rd. $1.
205. **Alta:** Wetaskwin — Reynolds Museum, Open May 1-Oct. 1. $1.50; child, 50¢.
206. **N. S.:** Yarmouth — Firefighters Museum, 451 Main St.*
207. **Ont.:** Niagara Falls — Antique Auto Museum, 1871 Falls Ave.*
208. **Ont.:** Oshawa — Canadian Automotive Mus., 99 Simcoe St. S. $1.50; child, 50¢.
209. **P. E. I.:** Bonshaw — Car Life Museum. Open May-Dec. $1; child, 50¢.
210. **P. Q.:** Delson — Canadian Rwy. Mus.*
211. **P. Q.:** St. Constant -- Canadian Railway Museum, 1224 St. Pierre St. Open 2nd week May to Labor D. 75¢; child, 35¢.
212. **P. Q.:** Valcourt — J. A. Bombardier Museum. Free.

SCIENCE

213. **Ala.:** Anniston — Regar Mem. Museum of Natural History, E. 10 St.*
214. **Ariz.:** Tucson — Arizona-Sonora Desert Museum. $2; child, $1.25.
215. **Ark.:** Little Rock — Museum of Science and History, 500 E. 9 St. Closed Mon.
216. **Calif.:** Los Angeles — Calif. Museum of Science and Industry, 700 State Dr. Closed Thanksgiving, Christmas. Free.
217. **Colo.:** Boulder — Natl. Bureau of Standards Laboratory, 325 Broadway. Closed Sat., Sun., holidays. Free†
217. **Colo.:** Boulder — Natl. Center for Atmospheric Research, 1850 Table Mesa Dr. Closed weekdays, holidays. Free.
218. **Colo.:** Denver — Museum of Natural History, City Park.*
219. **Conn.:** New Haven — Peabody Museum of Natural History, 170 Whitney Ave. Closed July 4, Thanksgiving, Christmas, New Year. 75¢; child, 25¢.
220. **Conn.:** New London — Thames Science Center. Gallows Lane. Closed holidays.
221. **Del.:** Dover — Del. State Museum, 316 S. Governor Ave. Closed Mon. Free.
222. **Del.:** Greenville — Del. Museum of Natural History, Rte. 52. Closed Mon., Tues. $1.25; child, 75¢.
223. **D. C.:** Washington — Natl. Museum of History and Technology, Smithsonian Inst., 14 St. & Constitution Ave. Closed Christmas. Free.
224. **Fla.:** Miami — Museum of Science, 3280 S. Miami Ave. Closed Christmas. Free.
225. **Ga.:** Atlanta — Fernbank Science Center, 156 Heaton Park Dr. Free.
226. **Hawaii:** Honolulu — Bishop Museum, King's Alley. $1.75; child, $1.
227. **Idaho:** Twin Falls — Herrett Arst and Science Center, 1220 Kimberly Rd. Closed Sun. Free.
228. **Ill.:** Chicago — Museum of Science and Industry, E. 57 St. & S. Lake Shore Dr. Closed Christmas. Free.
229. **Ind.:** Connersville — Reynolds Museum of Science and Industry, S. Vine St.*
230. **Ind.:** Evansville — Museum of Arts and Science, 411 S.E. Riverside Dr. Closed Mon. Free.
231. **Iowa:** Cherokee — Sanford Museum, 117 E. Willow.*
232. **Iowa:** Des Moines — Des Moines Center of Science and Industry, Ashworth Park.*
233. **Iowa:** Waterloo — Museum of History and Science, 503 South St. Closed Mon., holidays. Free.

[Continued]

The time to buy a camping trailer right!

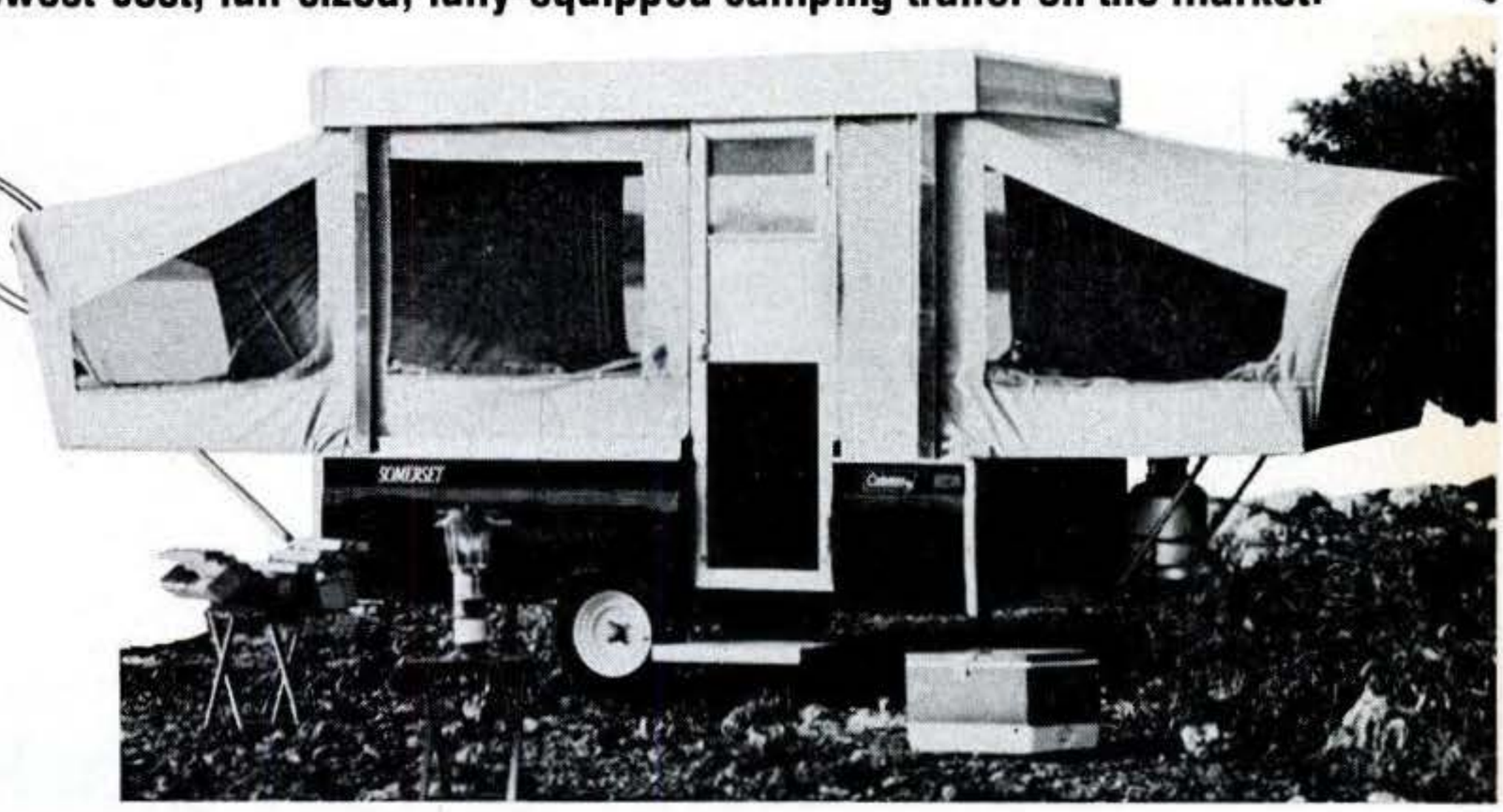
Coleman

GRUBSTAKE DAYS

SAVE $200 on the SOMERSET

the lowest-cost, full-sized, fully-equipped camping trailer on the market!

ONLY $1095* Regular $1295



The Coleman Somerset is the greatest value in a camping trailer. It sleeps six, has full-length aluminum door, combination access door/step, Coleman 3-in-1 cooler, 2 burner range, 115v electrical, portable water tank and much more. At this special Grubstake Day price it's the bargain of the year!

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- 2 Matching Coleman RV Sleeping Bags • 4 Pillows
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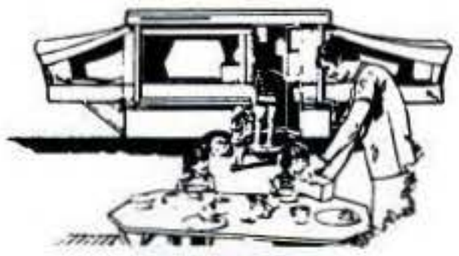

YORKTOWN
Luxury model with queen-size bed. Sleeps 7!

BRANDYWINE II
Big family model with double dinette. Feeds and sleeps 8!

BRANDYWINE
Spacious model sleeps 6 or 7, extra floor and storage space!

VALLEY FORGE
Popular deluxe model combining convenience and economy. Sleeps 6!

Getaway with a camping trailer bargain now! Coleman Grubstake Days specials are available only at participating Coleman Camping Trailer dealers and may be withdrawn without notice subject to product availability. In any event, offers expire June 30, 1973! For literature and name of nearest dealer write The Coleman Company, Inc., Camping Trailer Division, Somerset, Pa., 15501...or

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Coleman **Camping Trailers**

the camper's camper

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PS Guide to Science and Technology Attractions

[*Continued*]

234. **Kans.:** Lawrence — Museum of Natural History. Univ. of Kansas.
235. **Ky.:** Louisville — Museum of Science and History, 743 S. 5 St. Closed Sat., Sun., holidays. Free.
236. **La.:** Baton Rouge — La. Arts and Science Center. Closed Mon. Free.
237. **Maine:** Brunswick — Peary-MacMillan Arctic Museum. Bowdoin College. Free.
238. **Mass.:** Boston — Museum of Science, Science Park. $2; child, $1.
239. **Mass.:** Springfield — Springfield Science Museum, 236 State St. Closed Mon. Free.
240. **Mass.:** Worcester — Worcester Science Center, 222 Harrington Way. Closed New Year's, July 4, Labor Day, Thanksgiving, Christmas. $1.50; child, 75¢.
241: **Mich.:** Ann Arbor — Univ. of Mich. Exhibit Museum, Geddes Ave. Free.
242. **Mich.:** Bloomfield Hills — Cranbrook Inst. of Science, 500 Lone Pine Rd. Closed holidays. $1.50; child, 75¢.
243. **Minn.:** Minneapolis — James Ford Bell Museum of Natural History, 17 and University. Closed holidays. Free.
243. **Minn.:** Minneapolis — Science Museum 300 Nicollet Mall. Closed holidays. Free.
244. **Minn.:** St. Paul — Science Museum of Minn., 30 E. 10 St. Free.
245. **Miss.:** Jackson — Museum of Natural Science, 111 N. Jefferson St. Closed Sat. aft. & Sun. Free.
246. **Mo.:** Kansas City — Museum of History and Science, 3218 Gladstone Blvd. Free.
247. **Mo.:** St. Louis — Museum of Science and Natural History, Oak Knoll Park. Closed Mon. Free.
248. **N. J.:** Newark — Newark Museum, 49 Washington St. Closed New Year's, July 4, Thanksgiving, Christmas. Free.
249. **N. J.:** Paterson — Paterson Museum, 268 Summer St.*
250. **N. J.:** Princeton — Princeton Univ. Natural History Museum, Guyot Hall. Free.
251. **N. J.:** Trenton — N. J. State Museum, 205 W. State St. Free.
252. **N. M.:** Albuquerque — Sandia Atomic Museum, Kirtland AFB. Closed Thanksgiving, Christmas, New Year. Free.
253. **N. M.** Los Alamos — Bradbury Science Hall. Closed natl. holidays. Free.
254. **N. M.:** Roswell — Roswell Museum, 100 W. 11 St. Free.
255. **N. Y.:** Buffalo — Museum of Science. Humboldt Park. Closed Christmas. Free.
256. **N.Y.:** NYC — Amer. Museum of Natural History, 79 St. & Central Park W. Closed Thanksgiving, Christmas. $1; child, 50¢.
257. **N. Y.:** Rochester — International Museum of Photography, 900 East Ave. Closed Mon., Thanksgiving, Christmas, New Year. 50¢; child, 25¢.
258. **Ohio:** Cincinnati — Museum of Natural History, 1720 Gilbert Ave. Closed Mon., natl. holidays. 50¢; child, 25¢.
259. **Ohio:** Cleveland — Museum of Natural History, Wade Oval, University Circle. $1; child, 50¢.
260. **Ohio:** Columbus — Center of Science and Industry, 280 E. Broad St. $1; child, 50¢.
261. **Okla.:** Oklahoma City — Science and Art Museum, 3000 Pershing Blvd. Closed Thnks., Christmas, New Year's, July 4.
262. **Ore.:** Eugene — Southwest Ore. Museum of Science and Industry.*
263. **Ore.:** Portland — Museum of Science and Industry, 4015 S.W. Canyon Rd., Closed Christmas. $1; child, 50¢.
264. **Pa.:** Philadelphia — Franklin Institute, 20 St. & Parkway. $1:50; child, $1.
264. **Pa.:** Philadelphia — Acad. of Natural Sciences, 19 St. & Parkway. Closed Thanksgiving, Christmas, New Year. $1; child, 50¢.
265. **Pa.:** Pittsburgh — Carnegie Museum, 4400 Forbes Ave. Free.
266. **R. I.:** Providence — Roger Williams Park Museum. Closed Christmas, New Year's, Thanksgiving, Election Days. Free.
267. **S. C.:** Columbia — Science Museum, 1519 Senate St. Free.
268. **Tenn.:** Gatlinburg — World of Science, 956 Parkway.*
269. **Tenn.:** Oak Ridge — Amer. Museum of Atomic Energy. Closed Thanksgiving, Christmas, New Year. Free.
270. **Tex.:** Amarillo — Helium Monument Time Column and Museum, I-40 and Nelson.
271. **Tex.:** Dallas — Museum of Natural History, Fair Park. Closed Christmas. Free.
272. **Tex.:** Ft. Worth — Museum of Science and History, 1501 Montgomery St. Closed major holidays. Free.
273. **Tex.:** Houston — Museum of Natural Science, 5800 Caroline St. Closed Thanksgiving, Christmas, New Year. Free.
274. **Utah:** Salt Lake City — Utah Museum of Natural History.*
275. **Vt.:** St. Johnsbury — Fairbanks Museum, Main St. Free.
276. **Wash.:** Richland — Handford Science Center, 825 Jadwin. Closed Mon. Free.
277. **Wash.:** Seattle — Museum of History and Science, 2161 E. Hamlin. Closed Mon.
278. **Wyo.:** Laramie — Univ. of Wyo. Geological Museum. Closed holidays. Free.
279. **Ont.:** Ottawa — Natl. Museum of Science and Technology, 1867 St. Laurent Blvd. Closed Mon. Free.
280. **Ont.:** Toronto — Ontario Science Centre, 770 Don Mills Rd. Closed Christmas. $1.50; child, 25¢.

*Hours and/or admission fees not available.

†Advance notice or reservations required.

Note: It is advisable to write or call in advance if you're planning a big detour to visit.

True Grit. When ordinary blades can't cut it.

RECOMMENDED CUTTING APPLICATIONS FOR "GRIT-EDGE" BLADES

Material	Rod Saw	Hack-saw	Saber Saw	Circ. Saw
Ceramic Tile	X	X	X	
Slate	X	X	X	
Marble	X	X	X	
Flagstone	X	X		
Brick	X	X		
Glass	X	X		
Fiberglass	X	X	X	X
Tempered Hardboard			X	X
Asbestos Cement	X	X	X	X
Composition Board			X	X
Synthetic Marble	X	X	X	X
Plywood			X	X
Plaster			X	X
Counter Top Material	X	X	X	X
Hardwood Flooring			X	X
Stranded Cable	X	X		
Spring Steel	X	X		
Hardened Chain	X	X		
Stainless Steel	X	X	X*	
Tailpipe Bolts	X	X		
Cast Iron	X	X		

*requires coolant and variable speed machine.

"GRIT EDGE" When ordinary blades can't do the job, Remington "Grit-Edge" blades take over. They take the tough out of tough jobs, saw through "unsawable" materials.

How? Hundreds of tungsten carbide particles permanently bonded to the blades make them a match for materials that usually call for expensive diamond or solid tungsten carbide toothed blades. And if that isn't true grit, what is?

Remington "Grit-Edge" blades are available for Hacksaws, Saber Saws, Circular Saws, Bandsaws, and as a Rod Saw. The only thing ordinary about them is their low cost, which is a bargain considering their long life and the jobs they do.

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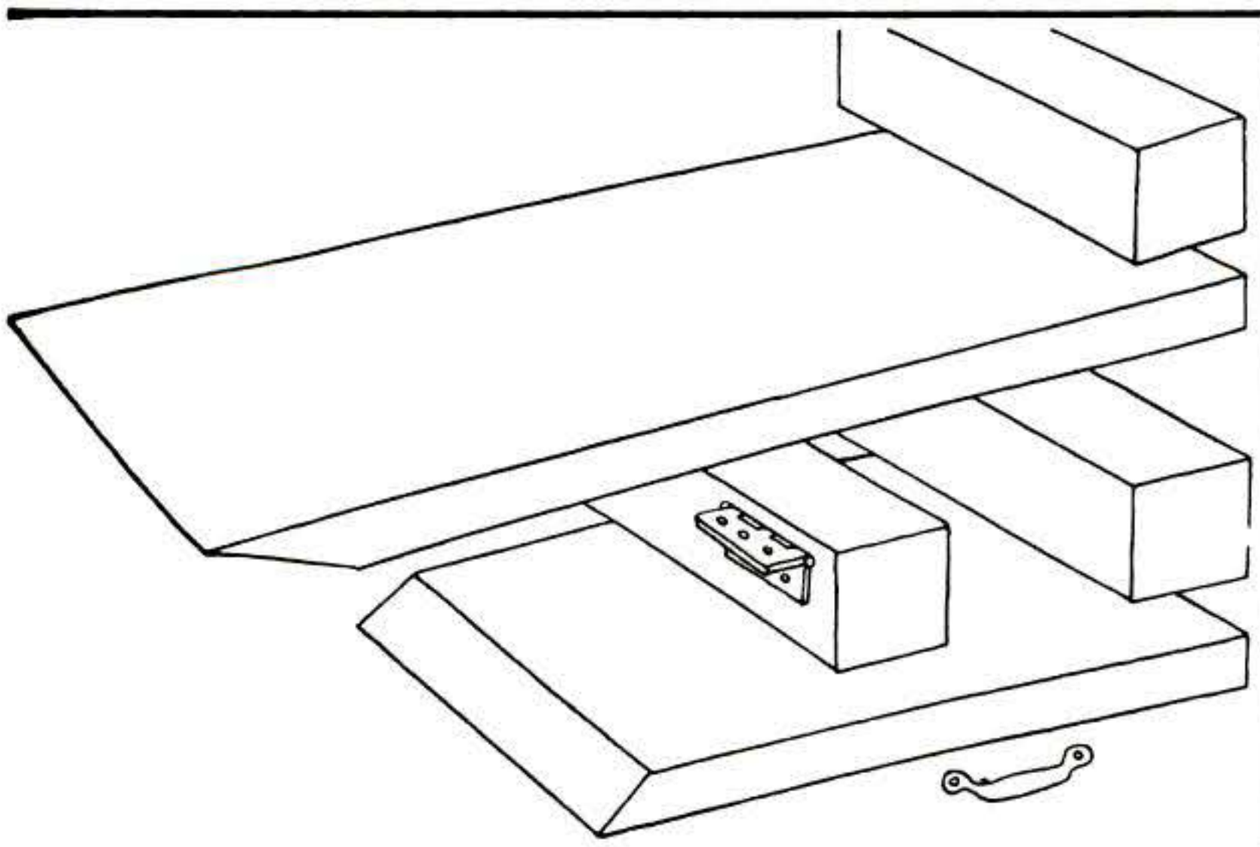

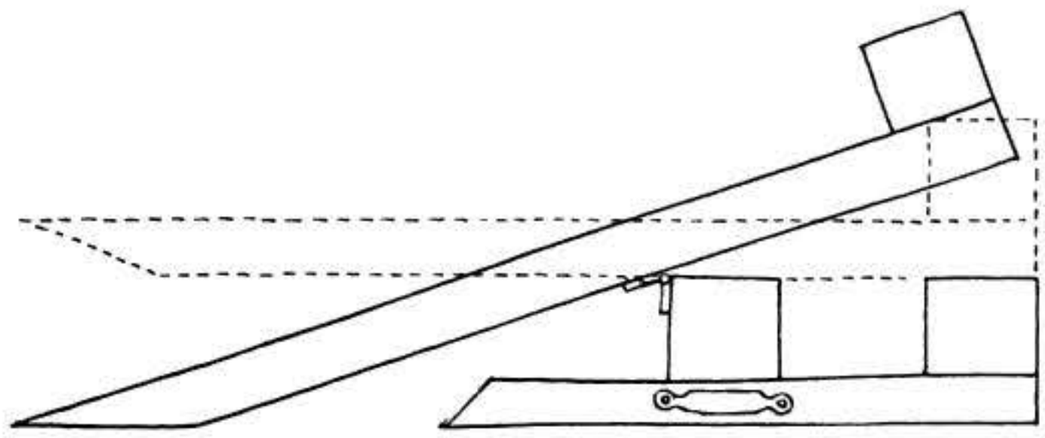

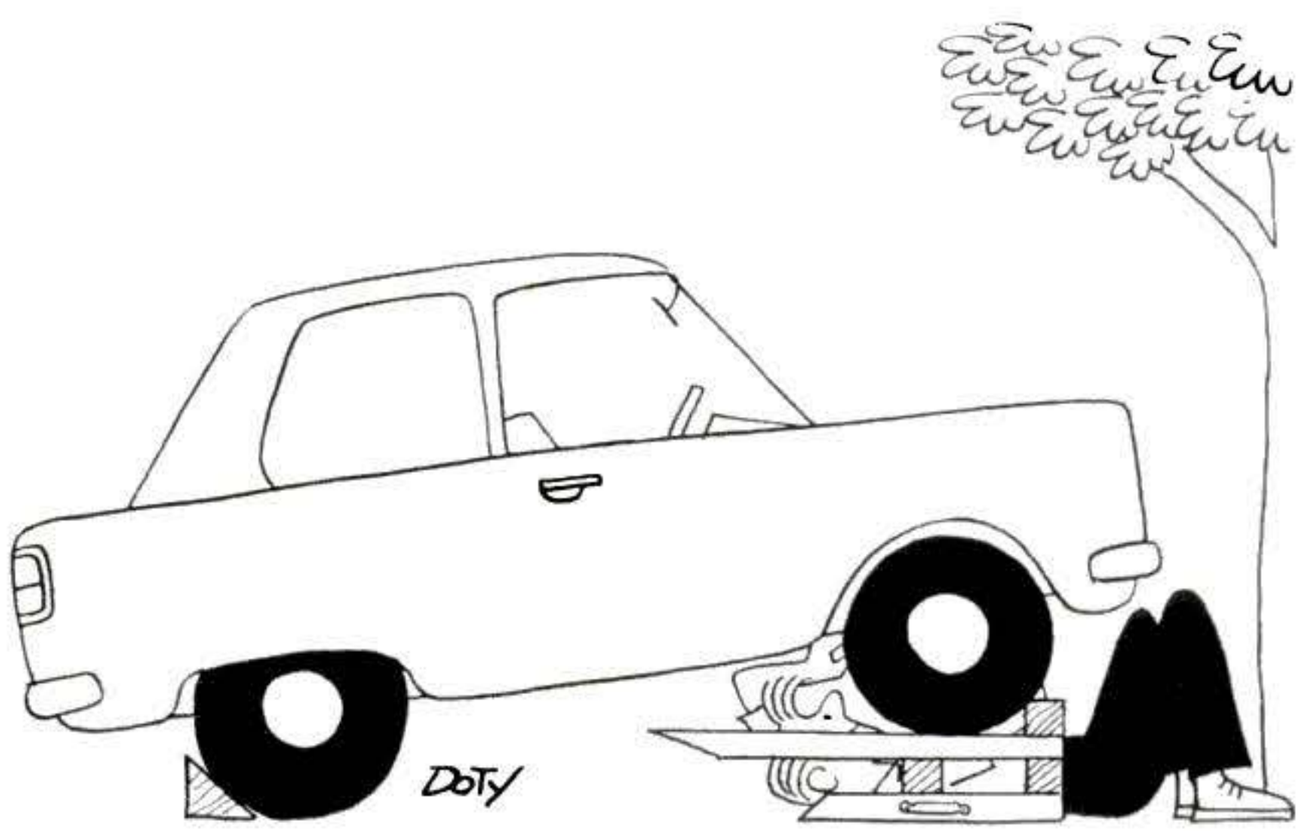

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APRIL 26 - MAY 12, 1973

NOW...SHOP YOUR LOCAL NRHA HARDWARE-HOUSEWARES STORE AND SAVE ON FAMOUS BRANDS

WIN ONE OF 8 CARS

BY American Motors

YOUR CHOICE OF A HORNET HATCHBACK OR A JEEP COMMANDO

PLUS 1,786 OTHER PRIZES!
Nothing to buy...you may win!

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April 26 - May 12, 1973

This is your entry form to enter the big Sweepstakes.
No purchase required...no slogans or jingles to write.

EASY TO WIN!

Simply deposit this coupon at any participating Hardware-Housewares Store displaying the Spring Happy Home Values emblem at any time from April 26 to May 12, 1973. You may win one of eight cars by American Motors (choice of Hornet Hatchback or Jeep Commando) or one of 1,786 other prizes.

Note: Some participating stores may not stock all items shown.

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CITY _____ STATE _____ ZIP _____

DEALER'S NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

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TURN PAGE FOR SPECIAL SAVINGS

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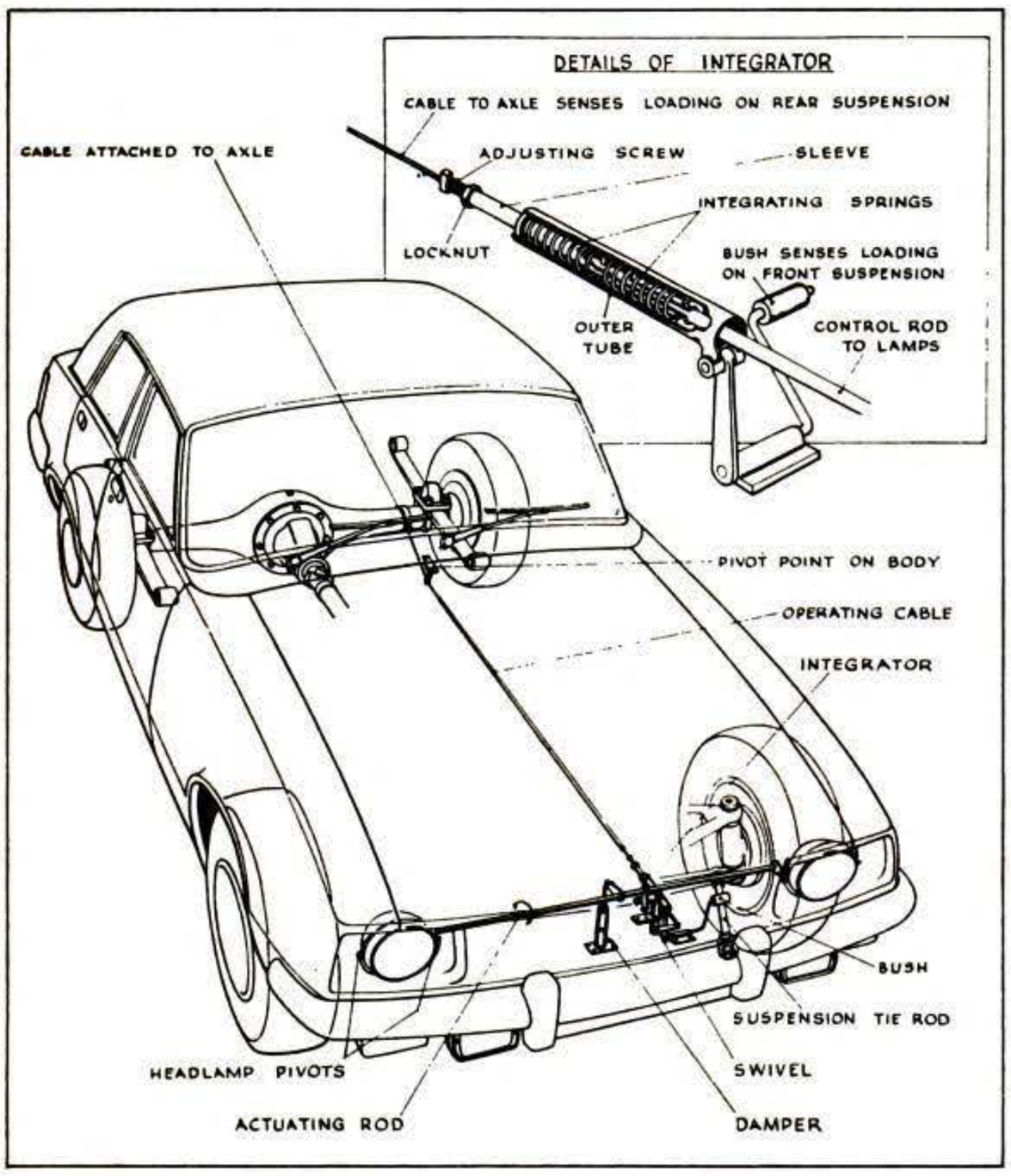
Headlight Leveler Keeps You on the Beam



By 1975 all new American cars must be equipped with self-leveling headlights. With this in mind, a British manufacturer is promoting a simple device that should take care of the problem and still add only $10 to the showroom price.

An "integrator" mounted in the front of the car transmits relative positions of front and rear axles to pivoted headlights, which are interconnected by an actuating rod. A single cable, located by an adjacent reference bracket, signals movement of the rear axle, live or independent. From the separate displacements, it mechanically computes the actual attitude of the car body relative to the road by a differential action, tilting the headlights accordingly.

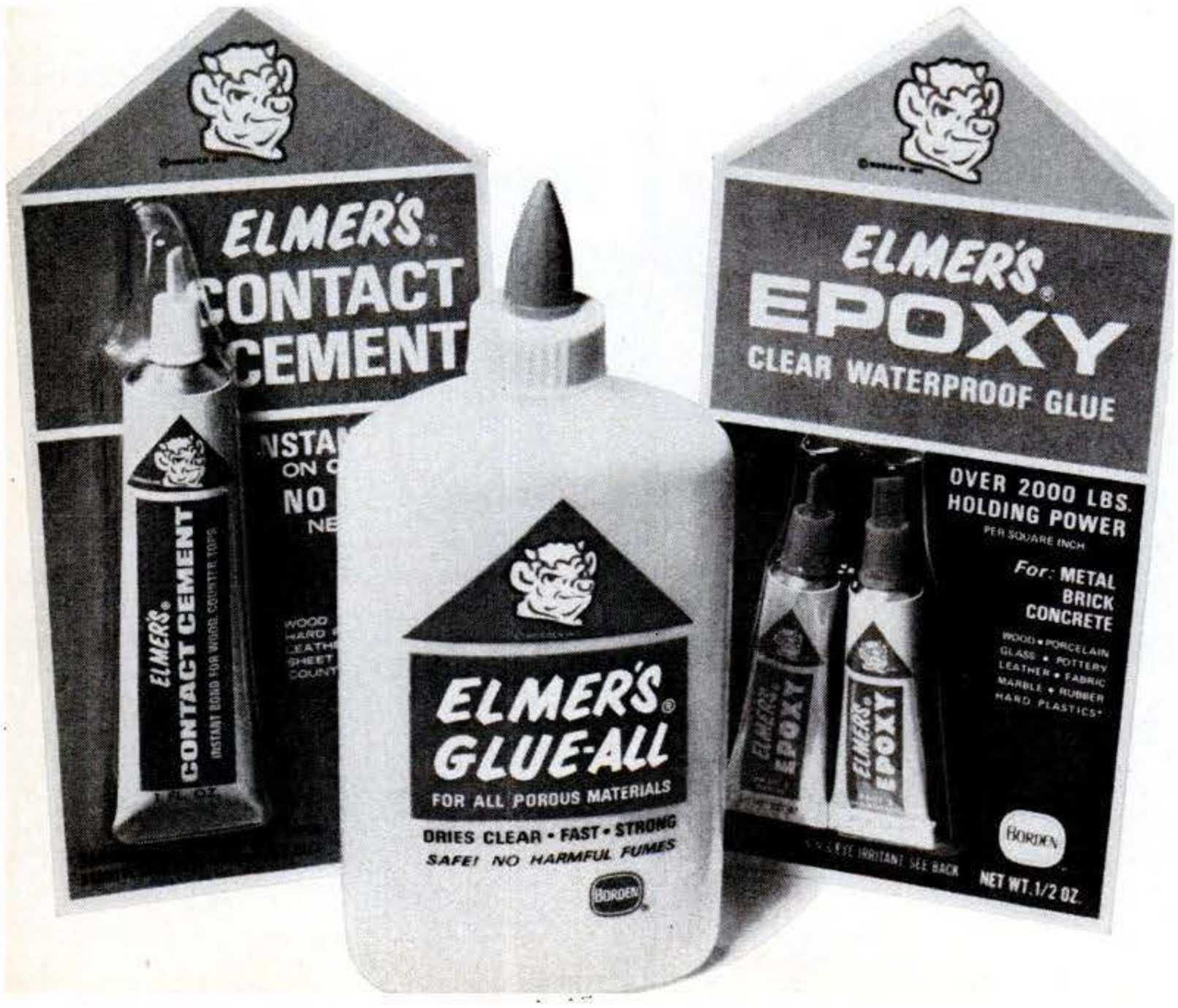
The axially aligned springs are housed in a moving tube whose rear end is joined to the other end of the rear coil. The front end is hinged to a body-mounted crank pressing against the front suspension. Extending through both springs is a rear-axle cable that joins to the outer end of the front spring.

A collar separating the inner ends of the two coils is linked to a central control rod by a peg passing through a clearance slot in the smaller tube. The forward end of this rod rotates the headlight-actuating rod through a lever.

Operation is simple. If the back of the car sinks and the nose lifts due to loading or acceleration, the two signals to the integrator spring work together to lower the beams. If both ends drop because of even load distribution, the signals oppose each other and the headlight angle is unaltered.—*David Scott*

Integrator mounted on a suspension rod between a car's headlights receives signals from front and rear axles, automatically adjusts aim.

America's No.1 'holding' company.



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Elmer's Contact Cement: where you can't use clamps. Bonds instantly.

Elmer's. The glue that puts it all together. For good.

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For Elmer's brand new handyman booklet containing ideas on how-to "make and fix" many things around the house, send 25¢ for postage and handling to Elmer's "Make-It & Fix-It" Booklet, Dept. MFS, Box 266, Medina, Ohio 44256.

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PS Guide to the New Boat Trailers

[Continued from page 98]

that qualifies for 2500 pounds, anything over 2000 pounds is tandem as far as we're concerned," says Jack Craig of Gator. Tee Nee and other makers agree. Boats of about 18 feet are on the dividing line for single or double axles, depending on a particular boat's weight and the trailer's design limit.

With four wheels, tandems offer travel safety, but you pay double-axle charges on the turnpike. Maneuvering tandem trailers at the launch site is a little tougher; but their disadvantage is minimal and should not be considered if they are needed, Nick Roman says.

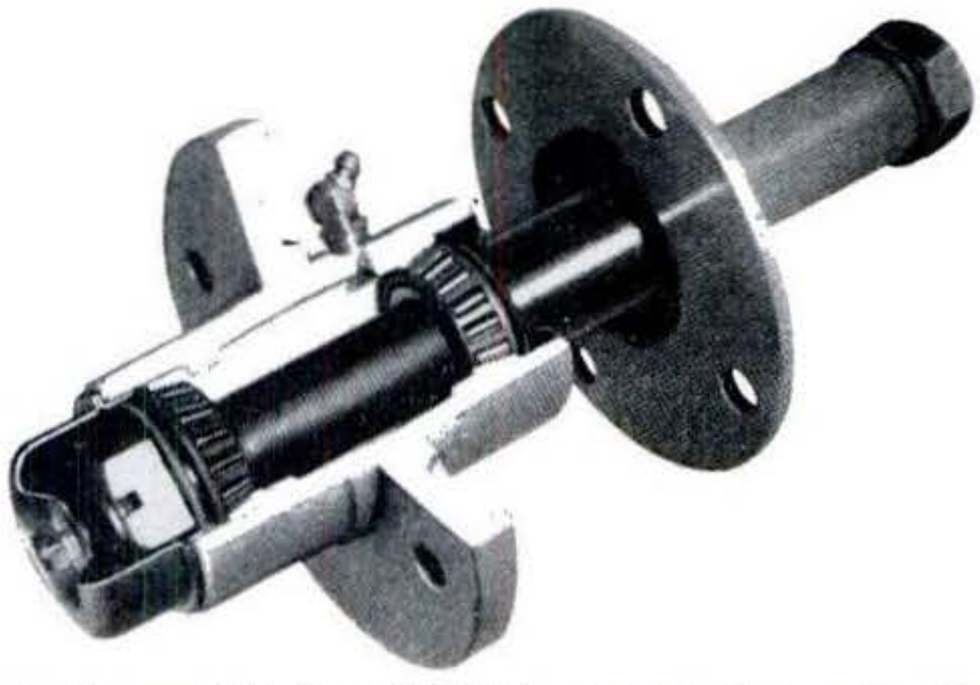
Practically every boat-trailer manufacturer offers water-resistant bearings in the 1973 trailers, either as standard equipment or as options. Alloy Marine is introducing its own patented waterproof hub as standard equipment on all trailers (see photo). All Holsclaw trailers have a centerless grounded axle, designed for a better fit for bearings. With double-lipped grease seal inside and O-ring seal outside the hub, Holsclaw guarantees hub assemblies to be waterproof for one year. Does this mean that you can go ahead and dunk, floating off and back on each time? You still have to take care of the brakes and other undercarriage components, especially if used in salt water.

New aluminum construction. Trailex is using extruded aluminum in place of steel, eliminating ubiquitous rust and also reducing the weight of trailers. But the biggest advantage, according to James Olney, is the completely new approach to trailer design that aluminum permits. Interlocks and sliding T bolts allow almost infinite adjustability in fitting a boat.

Normally, trailers come with a simple hand winch. A large trailer will have a geared winch. My advice is: If your boat has significant weight, remove this equipment promptly and install an electric-powered winch. It allows you to stand well off to the side, out of the line of fire if the cables snap, or the eyebolt of your boat should break. And it's a nice way to get that boat back on its trailer.

Safety standards. In any trailer you buy this year, be certain you get safety-engineered construction. All boat trailers sold are required to comply with the National Highway Safety Bureau standards on lighting, tire registration, and warranty-form filing (for five years). Each trailer must show a certification plate giving the model, serial, date of manufacture, gross vehicle-weight rating, and gross axle-weight rating with given tire sizes.

Unfortunately, nothing on the certification plate tells you what the real capacity of that trailer is. You've got to go to the maker's literature for that. PS



New waterproof hub on '73 Alloy trailers: Spring-tensioned, double-lipped seal turning on micro-finish surface keeps water out. Hub can be greased without removing wheel.

Shop Talk

News and views on tools and materials

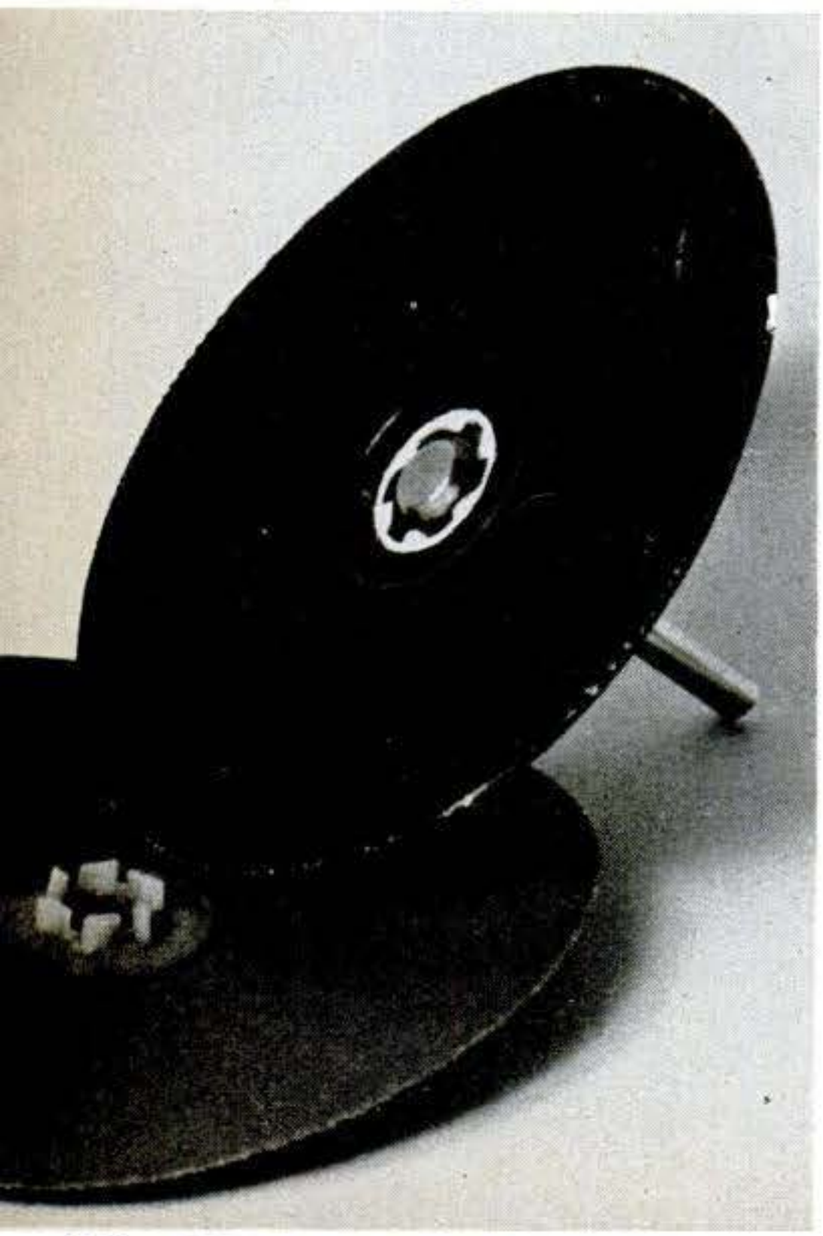
By A.J. HAND

An update on the return of the Shopsmith—good news and bad

Since our article on the return of the Shopsmith (Dec. '72, page 108), a few things have changed out at Shopsmith, Inc. First the bad news: Problems with late deliveries from suppliers have slowed production. In December we said the first run of 500 Mark Vs would be off the lines around the first of this year. Shopsmith president John Folkerth now tells me these machines won't be ready until about the end of March. Even so, if you're in a hurry to get hold of a Shopsmith you'll have to wait past March—all 500 Mark Vs in the first run are sold out. A second run—750 machines—will start around the first of May, and many of these are already sold. Those of you who have written to Shopsmith and received no reply, don't despair. You probably asked for an out-of-stock part; your letter was filed until the back orders came in. Mr. Folkerth says all queries are being acknowledged. Now for the good news. Shopsmith plans to reissue R. J. DeCristoforo's original Shopsmith bible, *Power Tool Woodworking for Everyone*, in the next few months. The book is out of print, and the publisher destroyed the original plates, so it's going to take a lot of work to bring the book back. But Shopsmith, Inc. has resurrected the Mark V, and can do the same with DeCris' book. Other good news from Tipp City: All single-purpose accessories are available right now, as are most replacement service parts for the Mark VII.

A better abrasive disk

If you've ever been dissatisfied with the rate at which sandpaper disks wear out or rip apart, you'll want to try Merit Abrasive's improved Power-Lock system. Merit attacks the durability problem with heavier disk backing and a unique disk mounting system. The mounting system was introduced in 1964, and it's proved its merit. Six plastic splines protruding from the back of the disk lock into the hub of a special rubber backing disk. The abrasive disks snap on or off in seconds, but won't fly off in use. Shredding that occurs with pressure-sensitive disks is virtually eliminated by laminating the abrasive to a tough nylon backing; the improved disks last and last. You can even clean them with paint thinner when they clog, and reuse them if you like. If you can't find Power-Lock in your area, write Merit Abrasive Products, 201 West Manville, Compton, Calif. 90224.



New cutting-tool handbook

If there's anything you want to know about cutting tools, a new 352-page book from Bendix probably covers it. There are standard dimensions, nomenclature, and technical data on taps, dies, drills, reamers, milling cutters, end mills, counterbores and keyway broaches. Other sections cover sharpening and reconditioning, and special drilling problems. In step with the rising importance of metrics, there's a section on the 40 metric tap sizes recommended by the International Organization for Standardization, as well as a drill chart and information on threads. You can get the book for $5 from Bendix Industrial Tools, 100 Dearborn, South Beloit, Ill. 61080.

Seagoing cement

Interested in building a ferro-cement boat? A good way to start on the right track is to pick up a copy of *The Ferro-Cement Boat*, by John Samson and Geoff Wellens. This is a revised edition of the 30,000-seller, *How to Build a Ferro-Cement Boat*. Ferro-cement is a rapidly-changing science and the new edition is right in step with the latest methods. An extensive bibliography makes the book a valuable key to further reading. It's $12.95 at bookstores, or direct from the publishers—Samson Marine Design, 833 River Road, Richmond, Vancouver, B.C. Samson, by the way, has an extensive selection of ferro-cement boat plans you might want to check out. Sailboats, houseboats, powerboats, and workboats are all represented, and the size range is impressive. PS

things to write for

- A 32-page brochure called "So You're Planning a Bathroom." Included are plenty of bathroom ideas, and scaled patterns of fixtures you can position on a floorplan of your room. It's a buck from American-Standard, Box 2019, New Brunswick, N.J. 08903.
- A question-and-answer booklet on lawn care. It's by M. J. Robey, a man responsible for a 36-hole golf course and six athletic fields. "Home Lawn Care" is $1.25 from M. J. Robey, Box 2126, W. Lafayette, Ind. 47906.
- National Bureau of Standards metric wall chart. This chart outlines the whole international system of metric units and contains tables for conversion to U.S. measures. The Government Printing Office, Washington, D.C. 20402 offers it in two sizes. A large wall chart over a meter wide is 55¢. A mini-version 14 inches wide (that's 356 millimeters) is 25¢.
- A do-it-yourself booklet, "How to Install Plexiglas Acrylic Sheet for Safety Glazing." It's free from Plexiglas Safety Glazing, Rohm & Haas, Box 784, Philadelphia, Pa. 19105.

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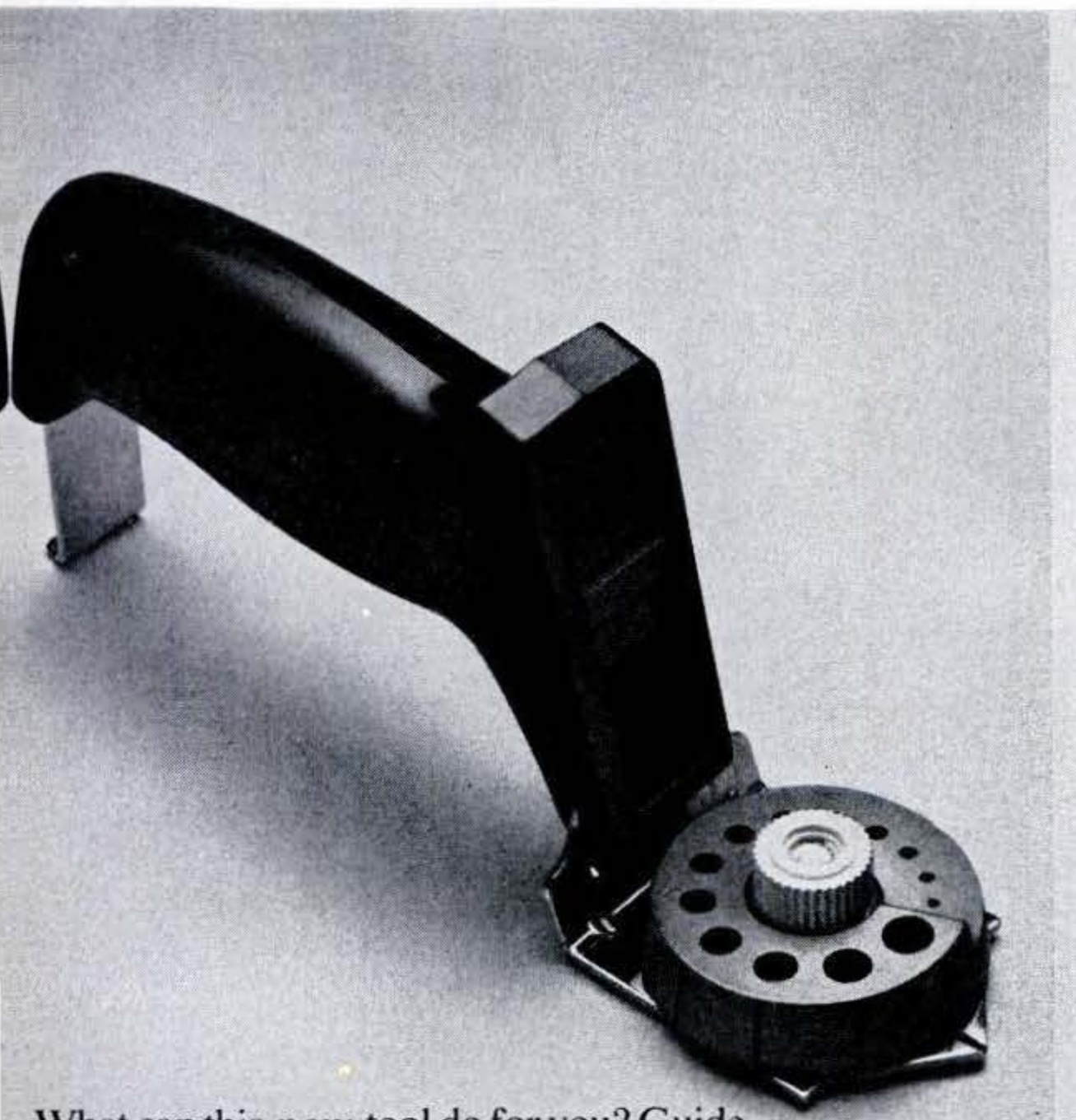
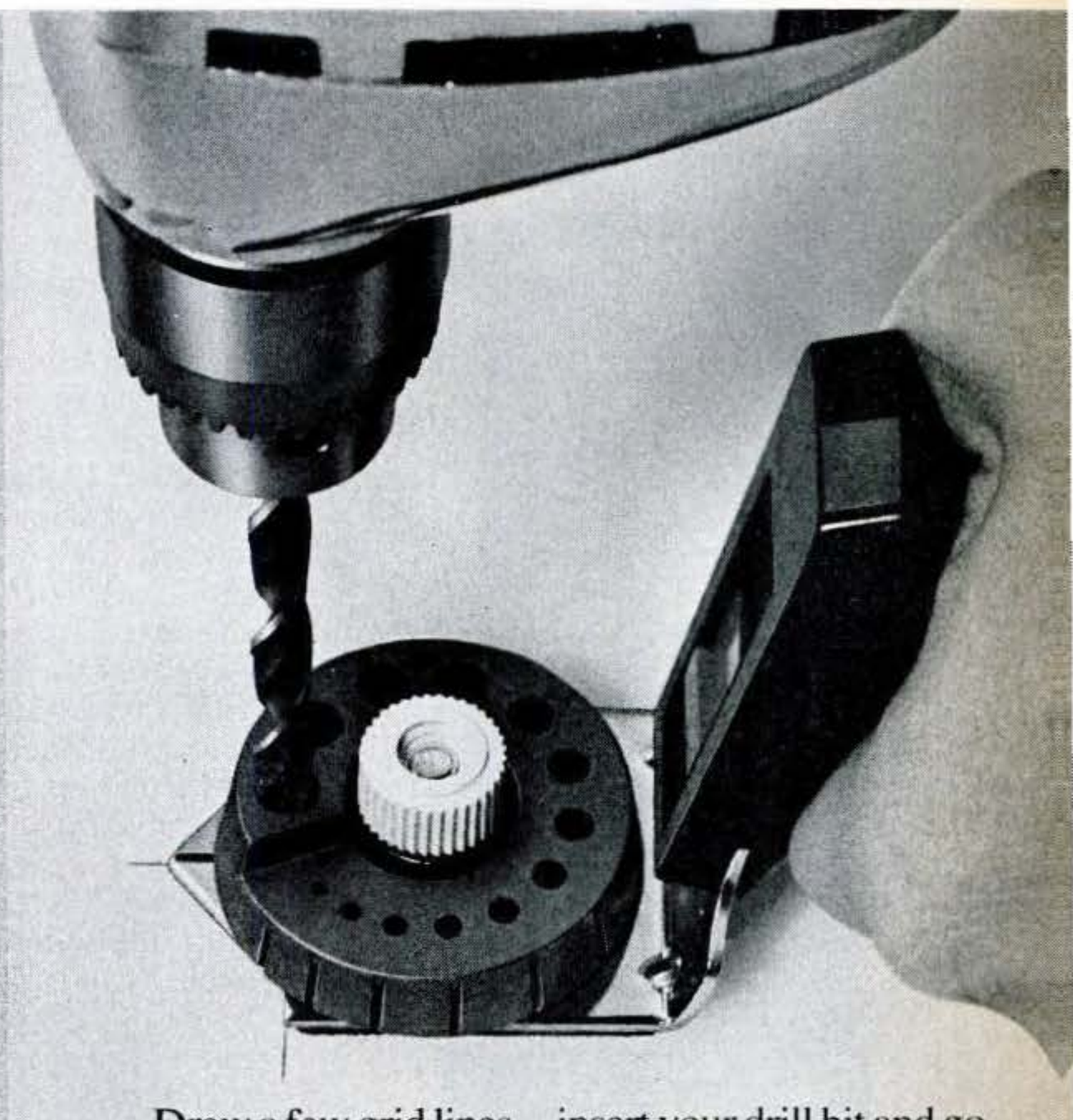
Stanley's Drill Guide has you going straight.





What can this new tool do for you? Guide your electric drill to a perfect right angle into metal, wood or plastic.

Draw a few grid lines — insert your drill bit and go to town! Drill Guide won't let the bit skitter about or mar the surface.

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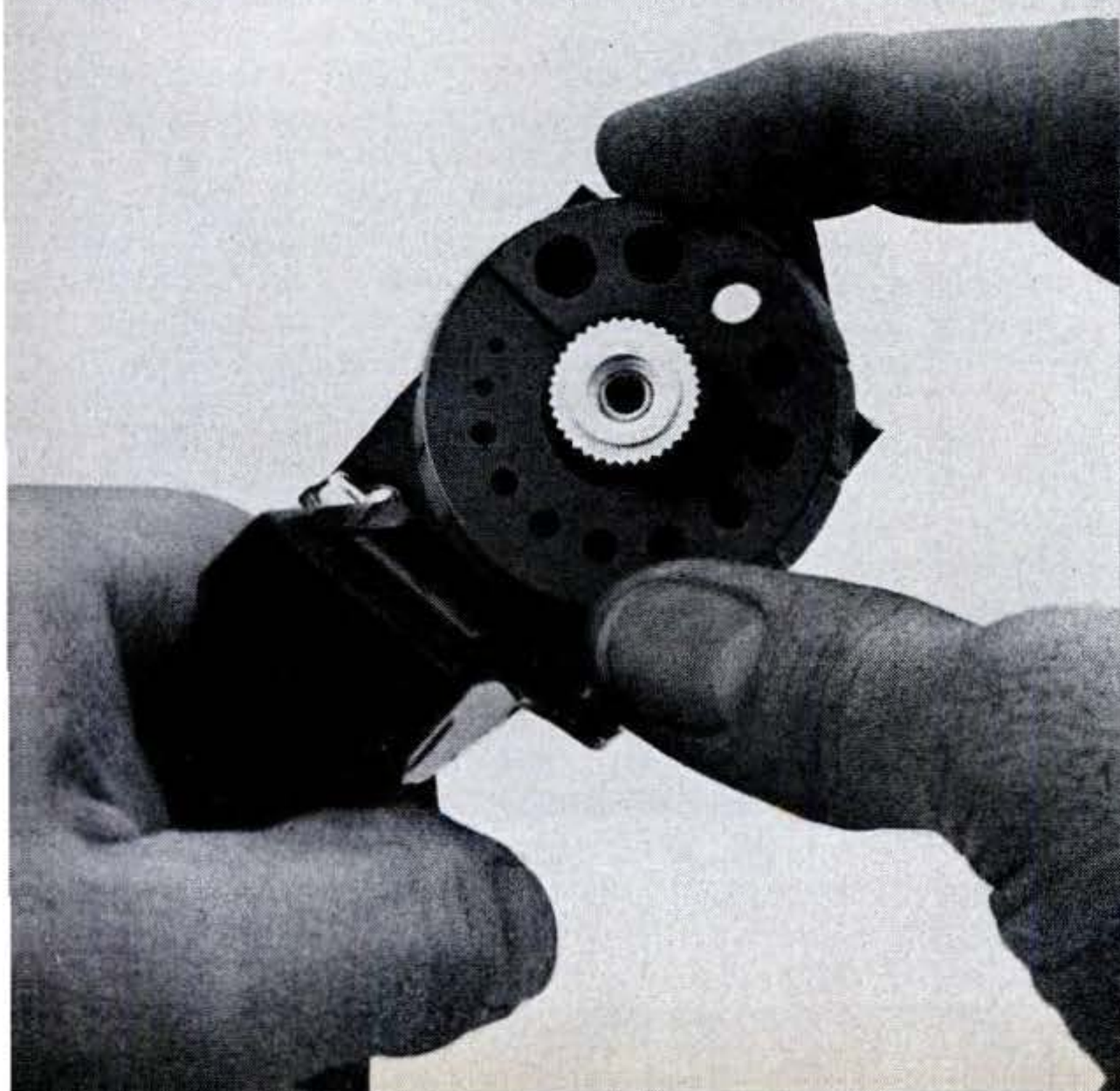
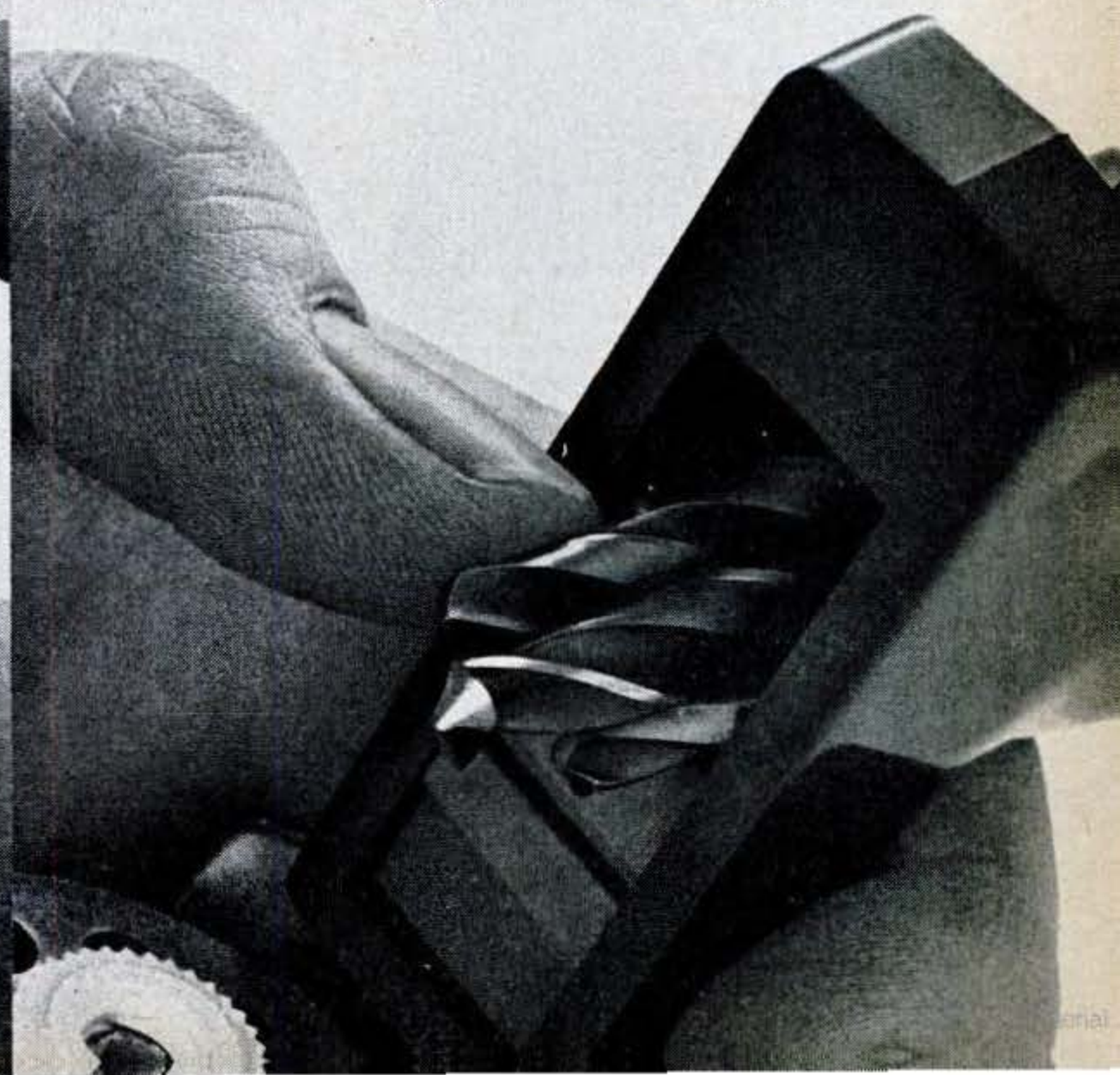
Just rotate the dial on the Drill Guide to the desired bit size. It accommodates 13 different bits, sized 1/16" to 1/4". Lock in place, drill away!

Handy sliding door storage in the handle keeps extra bits available. About $2.99 for a tool every drill owner will appreciate.





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GENERAL ELECTRIC

It's Superspray

[Continued from page 104]

so wanted to be able to use fuels contaminated with dirt or impurities–a requirement easily met by Babington's sprayer, which simply washes away the dirt. Dirt particles flow right over the ball with the liquid stream, or are blown away from the slots. "We have never had a problem with clogging," says Babington. "We could grab a fistful of dirt and throw it in this sprayer and it wouldn't have any effect at all."

This is good news for homeowners; most furnace breakdowns stem from clogged oil nozzles. A new nozzle based on Babington's invention and called Una-Spray should eventually be available in an oil burner for replacement or original installation. (See "More Comfort for Your Heating Dollar" PS, Sept. '72.)

Why slots? Babington experimented for years before deciding on the slotted-sphere configuration as the best design for most applications. "The reason for a slot instead of a hole," he says, "is that you get more spray per pound of air. The amount of spray depends on the perimeter of the hole rather than its area, which is why we use slots." The air pressure required to rupture the 10,000th-of-an-inch-thick film ranges from about five psi to 20 psi. A small recirculating pump drains the excess fluid from the beaker and returns it to the top of the ball. "The pump should provide just enough energy so that the liquid barely sloshes over the ball, and in most cases, that is only a couple of inches of water head. I've built units with only one-half inch of head."

Babington obtained his best results with the air slots at the equator and the liquid flowing from one pole to the other. "You should introduce the liquid 90 degrees away from the slot," he says, "so as to provide adequate time for the liquid to spread out into a nice, thin film over the orifice." Because the surface tension is not sensitive to gravity, the sphere can be tipped without disturbing the film.

"However," says Babington, "it won't spray exactly straight down. I've had no problem spraying about 15 degrees from the vertical. If I wanted to spray straight down, I'd have to try to get the drip tail away from the bottom of the ball."

Amazingly, even while explaining the problem, Babington managed to spray straight down by using a rod to pull the drippings away from the ball, much like drawing water along a nearly horizontal pencil.

The sprayer works best at generating fine particles–from 50 microns down to one or two microns, the size of smoke particles. For larger particles, Babington advises using a garden hose or conventional nozzle.

"The coarsest liquid dispersion is usually called a *spray*," he says. "I like to think that anything over 25 microns is a spray. Between 10 and 25 microns would be a *mist*. Below 10 microns would be an *aerosol*, or possibly a *fog*. I generally don't think of an aerosol until I'm below five microns. I think the word *nebulizer* is a medical term for a device that disperses an aerosol."

Ultra-fine control. Babington can control particle size by placing a shroud over the spray–important in medical applications. "It's nothing brilliant," he says, "just the old 'bug-on-the-windshield' principle. If you're driving at a certain speed, the large bug will hit your windshield, but the small bug won't–it will follow the air stream. Similarly, large particles will hit the sides of the shroud and drain off, while small ones pass out with the air stream."

To demonstrate, Babington aimed a direct water spray at my hand. In a moment, it was dripping wet. Then he put a shroud over the spray and placed my hand in front of its nozzle –my hand stayed dry. Apparently, the smaller particles were pulled along with the airflow and never struck my palm. Then, like a magician pulling another trick from his bag, he held a hand mirror in front of the shroud and the mirror fogged; some particles were still large enough to strike its surface. Next, he placed a flexible plastic hose over the shroud to further refine particle size. Amazingly, a fog as fine as cigarette smoke curled from the end of the hose. And these ultrafine particles did not fog the mirror.

Medical uses. Babington has conferred with many doctors on medical applications, and a medical nebulizer is soon to be marketed for treatment of respiratory diseases. "Inhalation therapy," says Babington, "is beneficial for people with emphysema, asthma, and cystic fibrosis, which is a genetic disease. Such patients benefit from inhaling the mist while sleeping. Doctors at Case Western Reserve have shown that by placing children with cystic fibrosis in a mist tent, they can extend their patients' lives well into adulthood."

To demonstrate, Babington pulled a light plastic mist tent from under his workbench and stuck his nebu-

Continued

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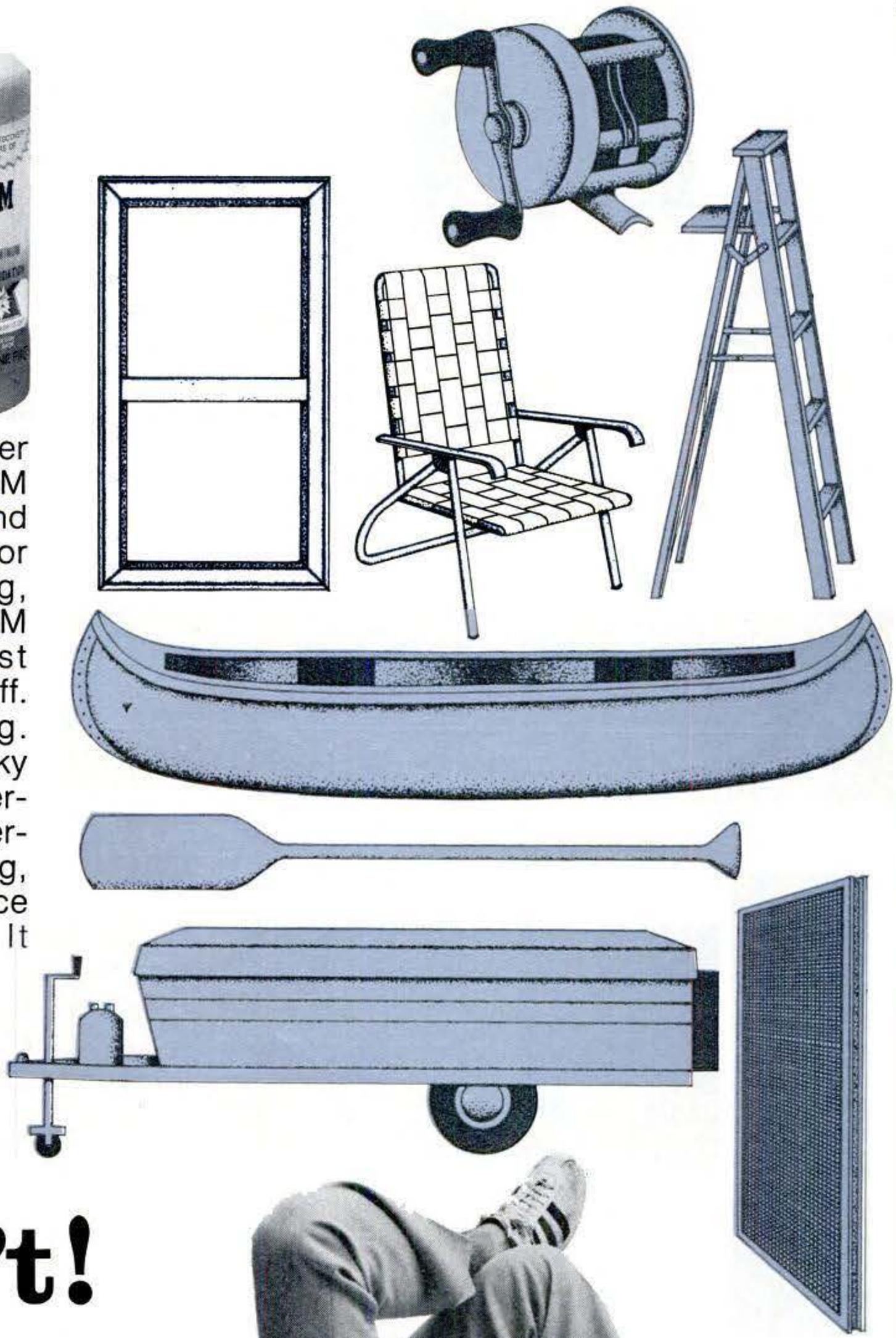

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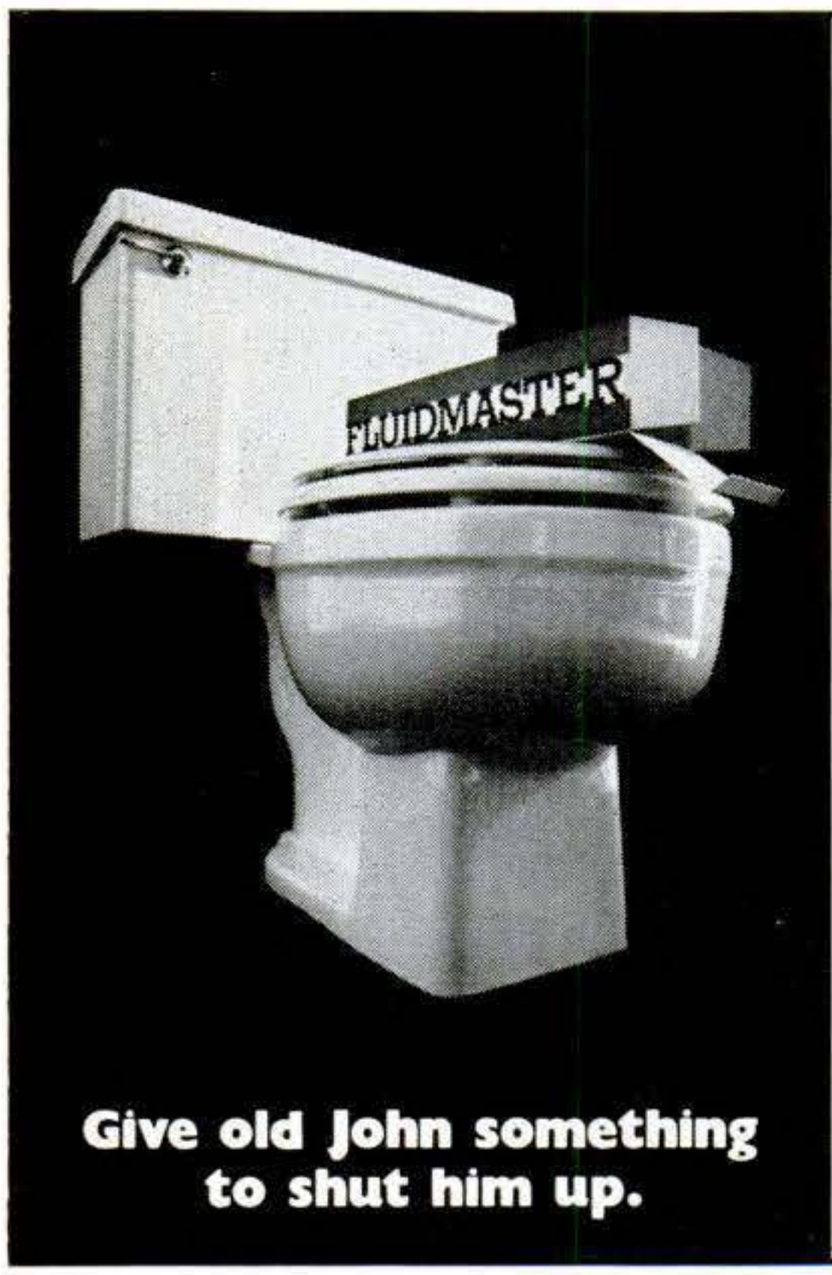

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It's Superspray

[*Continued*]

lizer hose inside it. Within minutes, it had filled with a white smoke-like mist as dense as any London fog. "A cystic fibrosis patient would sleep in this mist every night of his life, and the mist would have to be very dense," a point he emphasized by placing a high-intensity Tensor light inside the mist tent. The light vanished as if it had been dipped in ink: The mist was so thick that it completely blanketed the light. "You can see that it doesn't wet the floor," he added. "This is very important because it means that the mist doesn't wet the child."

Ecology boon. Some ecology problems may also be solved by the Babington sprayer. "About 90 percent of all the insecticide we're spraying is wasted," he says. "It just falls on the ground and does not kill airborne insects; it washes into the watershed and contaminates it.

"But there is an ultra-low-volume technique in which only one or two ounces of insecticide per acre are sprayed. A flying mosquito is more likely to hit a fine particle, which will float for a long time, than a larger particle, which quickly settles to the ground. Also, it's been found that it takes only a three- or four-micron particle to kill a mosquito. If he's getting hit with a 500-micron particle, there's a tremendous overkill." Babington is now working with the U. S. Department of Agriculture in experimenting with fine insecticide sprays.

Babington can recite a seemingly endless list of applications for his sprayer: "I did work on oil-mist lubrication for high-speed bearings. The regular oil film gets centrifuged out at very high speed, so it's better to fire a fine oil mist at the bearing. I have sprayed slurries of soups, teas, and other products that are sprayed into dried foods. I'm trying electrostatic paint spraying on assembly lines. There's no waste because the paint particles are so fine they float directly onto the product, drawn by electrostatic attraction."

He's also experimented with spraying water into furnace ducts for home humidification. He's installed such a device in his home, using a simple aquarium pump for spray power.

Babington plans to continue seeking new applications for his invention. "I'm basically an idea man, a research type," he says, "and I get my biggest kick when somebody asks 'Hey, can you help me spray this?' " He is also one of the few basement inventors who isn't all wet. PS

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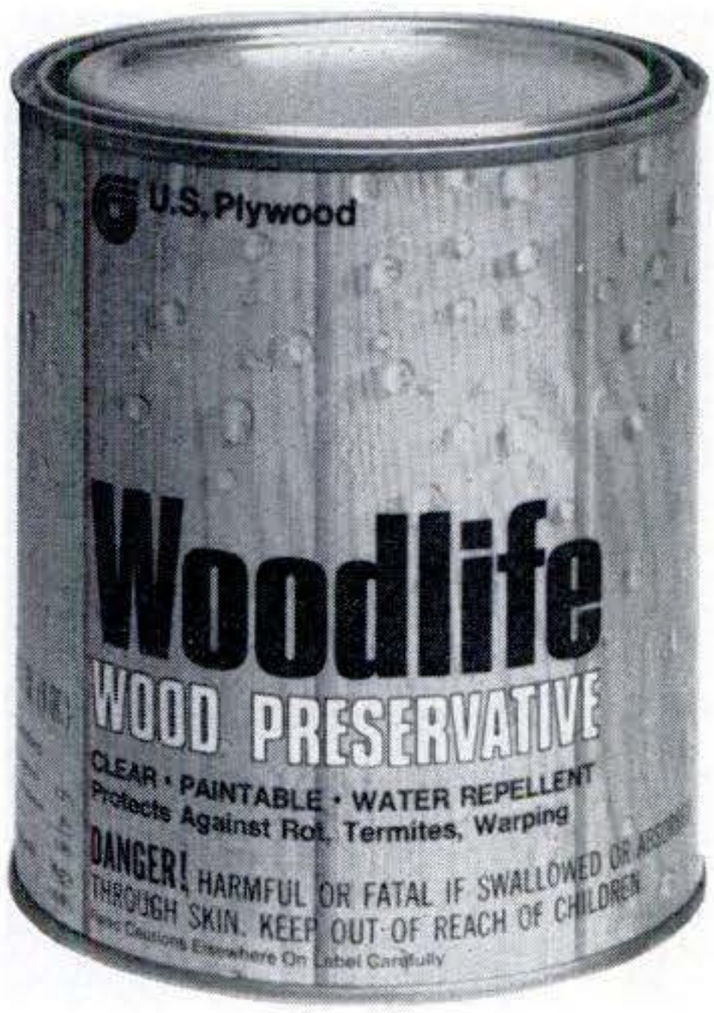

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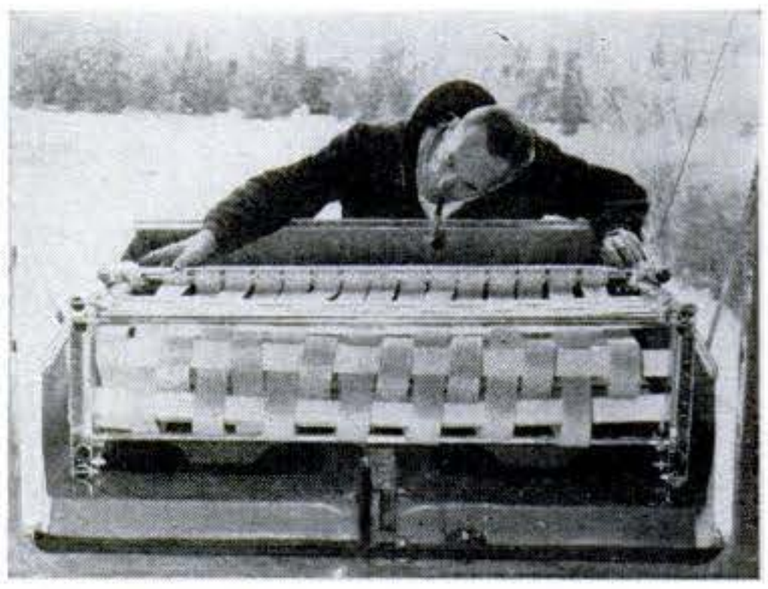
Bedroom for Van Camper

[*Continued from page 123*]

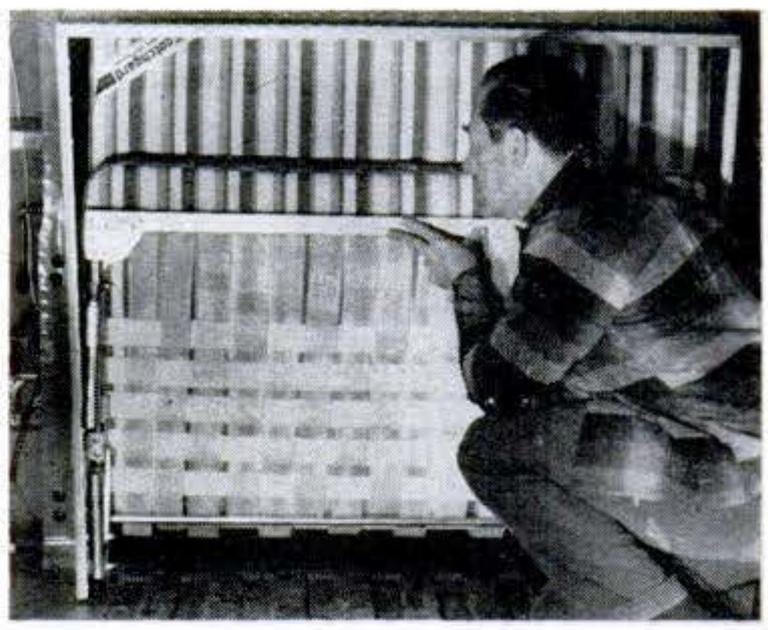
1/4-28x2" bolts and self-locking nuts.

One point of caution—the hinge mounts on the upper door window frame with #8 pan head sheet metal screws. After your trials have established proper centering, mark screw-hole locations so you can find them after the floor interior is finished off.

Draft-tight. You'll want the rear doors to be as well insulated and draft-tight as you can make them. The door thickness allows two layers of 1½"-thick foam insulation. Cut the foam into blocks to fit the in-



Long webbing strips must be grommeted and held to the support tube before that tube is riveted to the bed frame. Adjust tensions evenly.



Standard length of our prototype bed leaves about a foot of space. You can add extra length here easily.

Get full plans from PS for stretching a van

Before you can install the bed shown, you need to stretch your van into a camper. How-to is explained in PS Plan 5553—Van Conversion. These four 17" by 22" pages of instructions contain the original PS article (cover story for August 1972) plus additional details, drawings, and explanations. Send $3.95 to PS Plans, Dept. 35, 355 Lexington Ave., New York, N.Y. 10017. Ask for plans by name and number; allow 3-4 weeks for delivery.

HAPPY HOME VALUES at Hardware-Housewares Stores

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Bedroom for Van Camper

[*Continued*]

terior contours and sized to slip through the panel openings. Install one layer of blocks, then cut the second layer so joints are staggered and do not fall on joints in the first layer. We used 4″-wide 3M heavy-duty pressure-sensitive cloth tape to further blank off openings that might permit drafts. This is important around the latch hardware where insulation can't hit working parts.

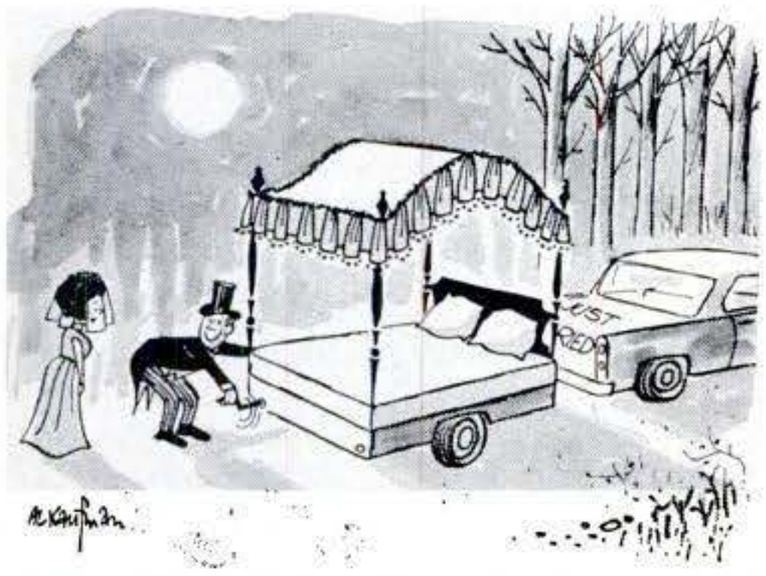
If your van has rear windows that open, they present a small problem. We removed the inside latch hardware and unscrewed the toggle from the glass clips. Two dogs of 3/16″ steel were substituted and the windows permanently drawn down gently but firmly against the seal rubber.

Curvature of glass and frames at this point required using 1″-thick insulation. We used Dyfoam Tufhide and saw-kerfed the interior face at 1″ intervals to let the insulation bend to the glass contour.

This material is polystyrene foam with a leathery finished surface laminated to each side. The surface is durable enough to accept reasonable wear and takes latex paint well. Before cementing in place, paint the surface that shows through the rear windows. While the mastic adhesive dried, we clamped the panels to the lower canopy rim with scrapwood blocks. Tufhide is made by Construction Products Div., W.R. Grace & Co., 62 Whittemore Ave., Cambridge, Mass. 02140. We'll use it in additional areas later.

Inner door panels. The .032″ aluminum here serves to seal against drafts, give a level support for the bed, and make the two doors into a solid box structure for rigidity and vibration resistance. Note that the upper sheet slides under the infolded lips of the canopy side panels, and the lower piece bends and folds under the door to conceal the door joint. Make a small cutout for the latch tongue.

We'll insulate and finish the canopy walls at the same time we do the interior of the van. But that's a story for later. PS



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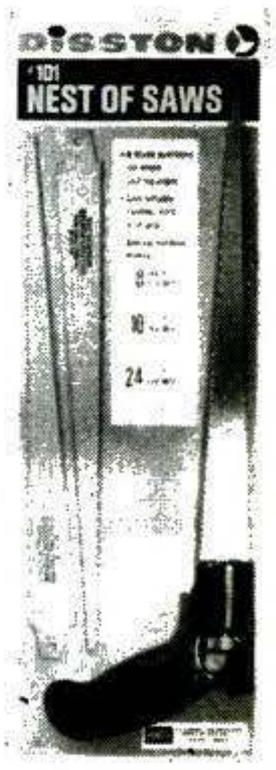

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Pool-Heating Panels Make the Sun Work for You

[Continued from page 117]

months for comfortable swimming.

An optimum site for panels is one facing south on the slope of a peaked roof. Other typical installations are along fences, on patio sun-shelters, and on flat roofs mounted on wooden frames tilted to the proper angle (roughly, in degrees, your latitude).

Panel support. Each 10-foot panel (35 square feet) weighs about 72 pounds when full of water. If you can walk on the supporting surface, it will easily support this well-distributed weight.

Pipes and fittings can be 1½-inch or two-inch ABS, PVC, or polyethylene plastic. Class-160 plastic irrigation pipe is adequate for the typical pressure of 10 psi or less. Some local codes may specify more-expensive Schedule 40, a thicker-walled pipe.

The biggest part of the installation job will be the pipeline, and frames to support the panels if you need them. Most people like to bury the dual pipes from pump house to panel array, or to run them unobtrusively along the bottom of a fence or behind shrubbery. Keep this in mind when you locate the panels.

On a roof, you can take the pipes up through the eaves or parapet, which involves holing and patching, or take them around or over the edge with elbows. Or you may wish to put the pipes tight beside an existing downspout where they'll seem less visible.

Pump-house plumbing is uncomplicated. You tap into the existing pool-circulation system after the filter, or between the filter and the gas heater if you have one. The existing pump will do the job unless it's in marginal shape. A ¾-hp motor usually is enough muscle.

Basic pump-house hardware needs are two Ts and a valve between them. A manual gate-valve is fine if you don't forget to open it and bypass the solar panels at times when they'll be losing heat instead of collecting it (little or no sunlight).

Automatic valve control. Optionally available is an automatic shut-off valve controlled by a small sunlight-sensing device installed with the panels. When the sun is bright enough to warm the panels at all, the valve closes and shunts water through the solar-heating system.

What does a system cost? One typical installation for a 450-square-foot pool involved seven 10-foot panels (245 square feet of panel surface, for $429), 250 feet of two-inch ABS irrigation pipe ($100), ten two-inch plastic elbows and fittings ($15), the optional automatically controlled valve ($96.50), and sales tax ($32.02) for a total of $672.52. The owner installed it during two weekends.

A 250,000-Btu-per-hour (input) gas heater for the same pool would have cost between $475 and $600, installed. That's $400 to $425 for the heater, the rest pays for installation of the gas line.

Flat-roof installation. Another owner tilt-framed five panels on a flat roof to heat a 400-square-foot above-ground pool. Panel, pipe, fittings, etc., totalled $342. He did the job, including a short run of buried pipes, in two weekends.

This practical application of solar heating should particularly appeal to those concerned about our looming energy shortage and the already existing natural-gas shortage.

The manufacturer is FAFCO Inc., 2860 Spring Street, Redwood City, Calif. 94063. PS

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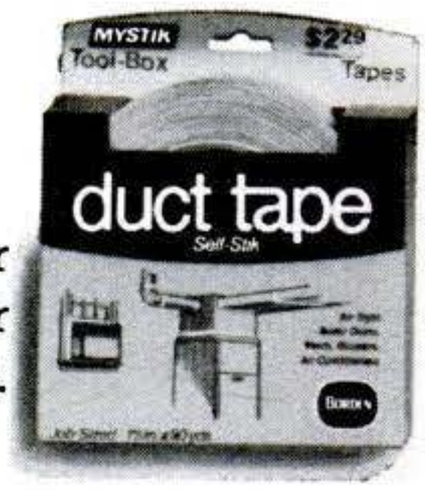

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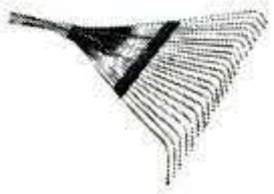

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How to Cope with Those RV Emergencies

[*Continued from page 121*]

A cranky automatic transmission can also be caused by having too little fluid in the system. Check the level when the engine is hot; fluid drains out of the torque converter when the engine isn't running.

Carry an extra can of the specific transmission fluid your rig requires. Never overfill, though. This could cause air bubbles and upset the control valves and servo pumps.

If your transmission fluid looks milky, you may be heading for trouble. This happens when water or glycol contaminates the fluid. Drain the milky fluid at once and replace it with fresh fluid before real trouble occurs.

Another emergency may occur when the throttle-return spring comes off at one end or both. This deprives you of throttle control. Unless the spring is lost, you can hook it back on and replace later whatever caused it to come loose.

Brake troubles. Motor-home and pickup-camper brakes get a hard workout, especially when you're traveling in mountainous areas. The brakes can fade if they become too hot from constant application while going down hills. The way to prevent this is to make your engine do the major share of the braking. Cursi recommends downshifting one gear going down hills from the gear you were in when you climbed. With automatics you can shift to Low if you stay below 40-45 mph. Otherwise use 2 (intermediate or super).

However, you may sometimes feel a sponginess in your brake pedal even if you take these precautions. This is probably caused by air trapped in your brake lines. The cure is to bleed some fluid to purge the air bubble, then top off with fresh fluid in the master cylinder.

It takes two persons to perform this operation. Have someone step on the brake pedal while you turn the bleed screw in the wheel cylinder to bleed fluid. When a steady stream comes out, tighten it up. Then check the brake pedal. If the sponginess has disappeared, chances are you've eliminated the air pocket. If the pedal is still not firm, continue the treatment to the other wheels until the trouble is corrected.

Another source of brake trouble is the brake-booster breather. Sometimes this filter is located in the battery compartment of motor homes. If you install a second battery, it could give off fumes in an overcharged condition, and this may adversely affect the booster's operation. You'll be wise to move the filter to another location rather than risk this.

A simple way to tell if the booster is okay is to pump the brake pedal three or four times with the engine off, then start up the engine. If the pedal goes down, your booster is good. If the pedal doesn't move, you're getting no booster effort.

Cursi says that the breather is the first thing to check as a cause of this condition. The booster filter should be changed every two years if it's located inside the motor home. If it is located outside, it should be changed more often.

Overheating bugaboo. Another common RV emergency, this one is frequently made worse by the fixes some RV owners attempt.

Never replace the thermostat unless you have the maker's part number. The identical thermostat is necessary for the proper circulation of coolant through the bypass. The wrong thermostat can close off the bypass and cause overheating. And never put a higher psi-rated pressure cap on your radiator than the engine manufacturer specifies. The system is designed to operate at a specific pressure.

Lugging your engine when climbing hills is always a possible cause of overheating. Downshift manually when the vehicle's speed drops down. If you continue to hold the throttle wide open while the rig is slowing down on a climb, it will cause overheating.

Toting a spare wheel on the front of your motor home or pickup camper cuts off cooling air needed by the engine. Find another place to carry the spare.

These fixes may solve problems when you're out in the woods. But preventive maintenance can ensure you against having any emergencies.

Here are some recommendations that Cursi makes to cut down mechanical failure:

Change engine oil every 90 days or 4000 miles–sooner when you run under dusty conditions. Change oil filters every second oil change; with *every* oil change when riding under dusty conditions. Lubricate the front end every 2000 miles. Replace coolant with 50/50 antifreeze and water once a year. Antifreeze is just as important in preventing overheating as in preventing a freeze.

Transmission oil should be changed when your rig reaches 32,000 miles, and every 20,000 miles thereafter. Wheel bearings should be repacked every year. Brakes should be checked at least once a year. PS

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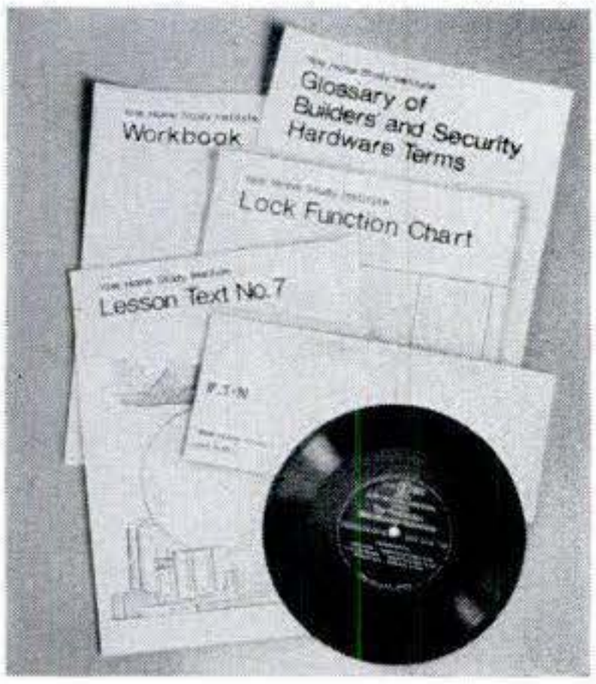

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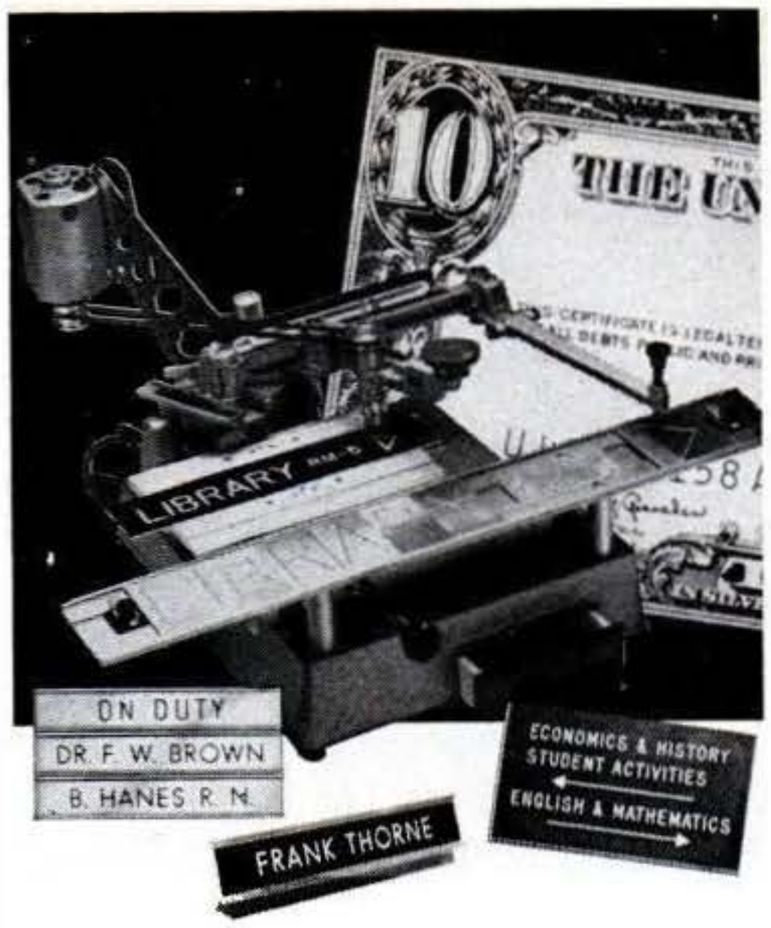

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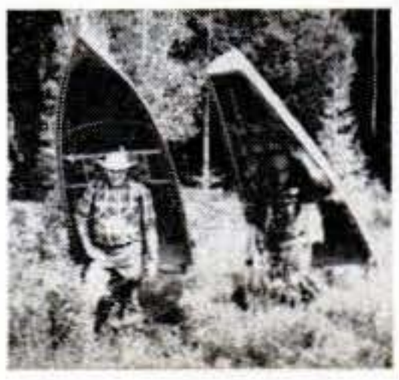

A/C for '73

[*Continued from page 81*]

a simple explanation on how to use it. There are many questions you may not have considered asking: Other appliances in use? How many people normally in the room? (A person gives off 400 Btu's per hour just living.) How many doors in the room frequently opened? You can get estimate forms free from AHAM at 20 N. Wacker Drive, Chicago, Ill. 60606.

Another thing you may want to try is use of a couple of room units or even only one [See "Cool Your House With One Window Unit?" PS, April '71] to cool more than one room. John Slattery recalls: "Once I used three air conditioners scattered about my house. I ran the furnace fan along with them and every room was quite comfortable."

Engineers concede that this approach won't give you the air distribution that a central system will, but the cost is less. Slattery's system had nearly 30,000 Btu's, so don't expect to skimp in capacity.

Clint Ring, GE's manager of product planning, went the big-unit route, too. "I have a guest room that we don't use very much, so I put a high-capacity unit in there. I run the furnace fan at its summer setting, close off the registers in the rooms I don't use, and everyone's quite comfortable. All the noise stays in the guest room; it's like having a cooling plenum."

Placing your air conditioner. Where should you put the unit? Which window? Through the wall? Put it where you think you'll get the best air circulation. "A lot of people think you shouldn't put an air conditioner in a window that's going to get a lot of sunlight, such as a western exposure," says Clint Ring. "But it doesn't matter. Shading the unit will not make a big difference in performance." The sun shining on the condenser section accounts for only a few hundred Btu's per hour, hardly significant in the total save-a-watt picture.

Care pays off. Keep units functioning efficiently: Clean or change the filter every few weeks. Dirty filters greatly inhibit the air-exchange rate. Second, oil the fan motor and tension the fan belt. Finally, clean the condenser coils (located outside the window). You can wash them at the beginning of the summer with a garden hose.

Now, put all the aforementioned suggestions to work that you can afford right now. You'll be more comfortable, eventually save money, and conserve some energy. PS

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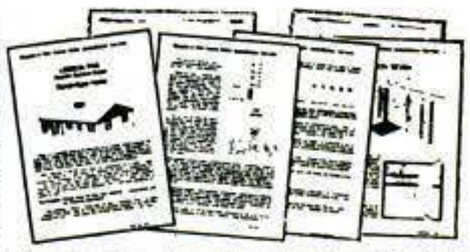

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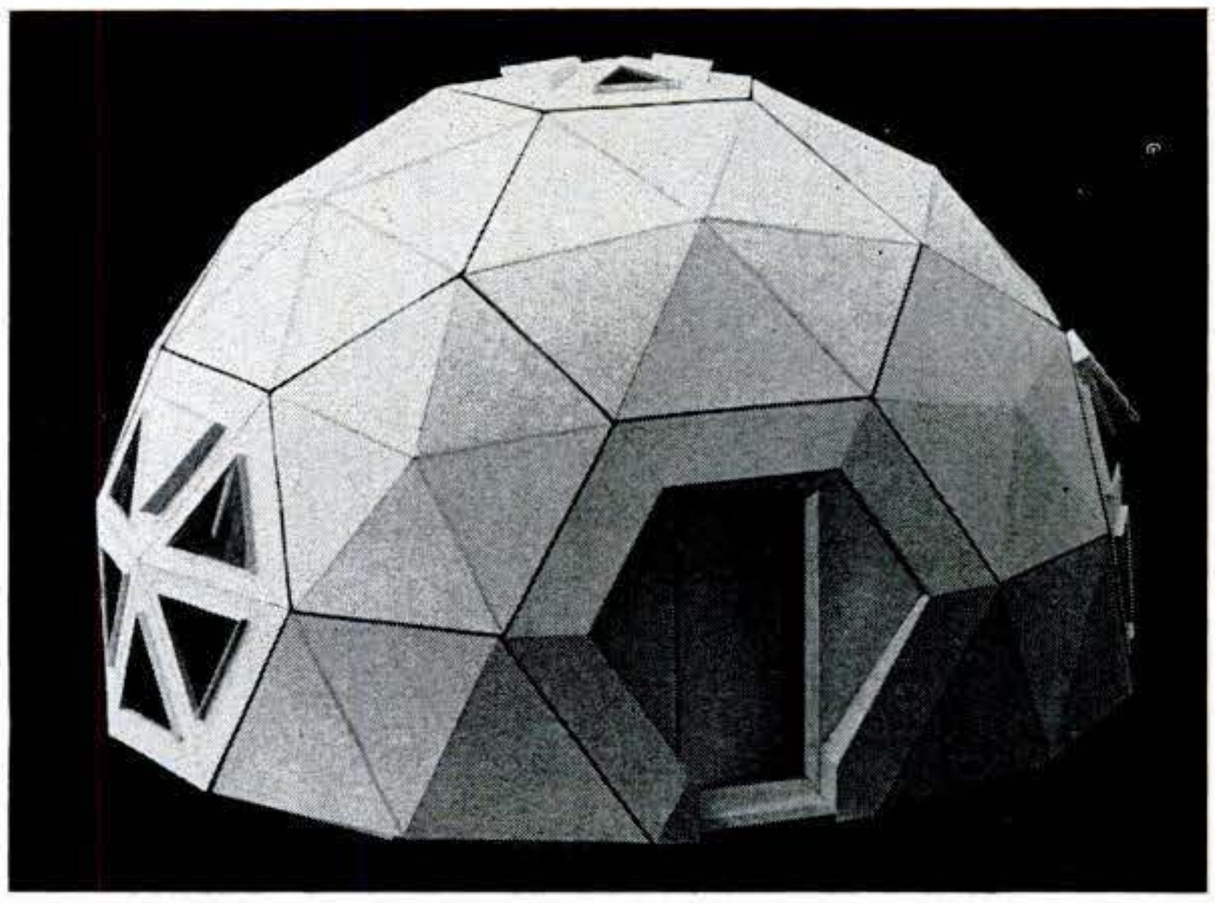

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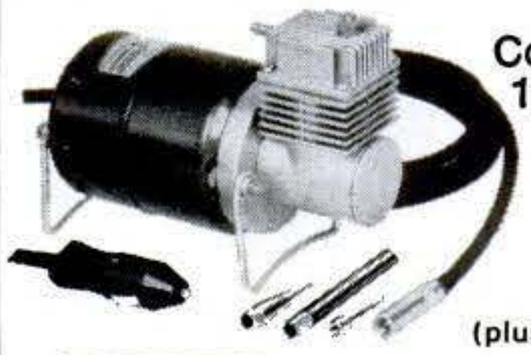

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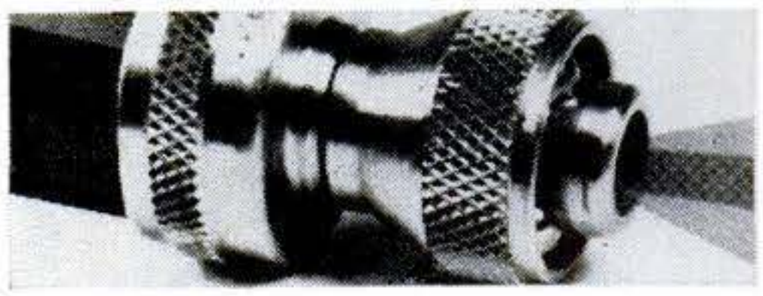

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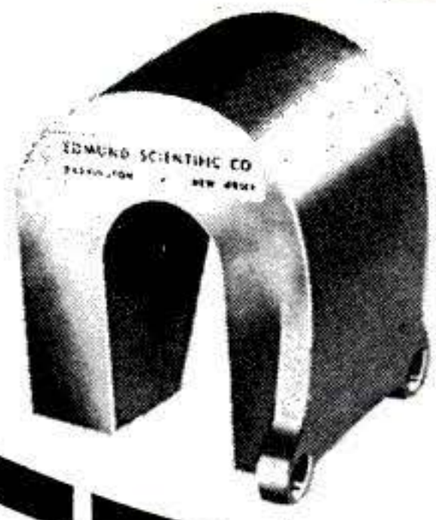

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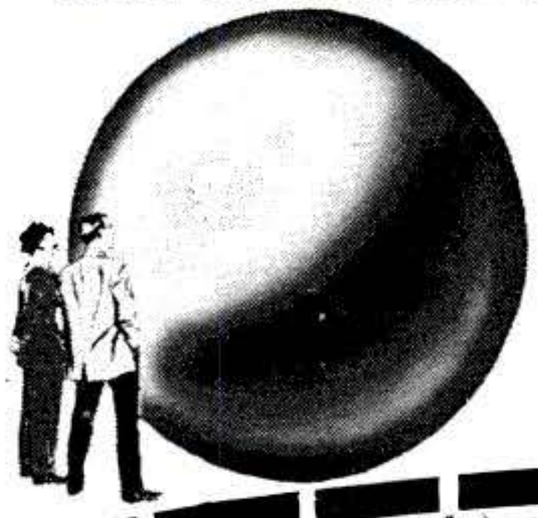

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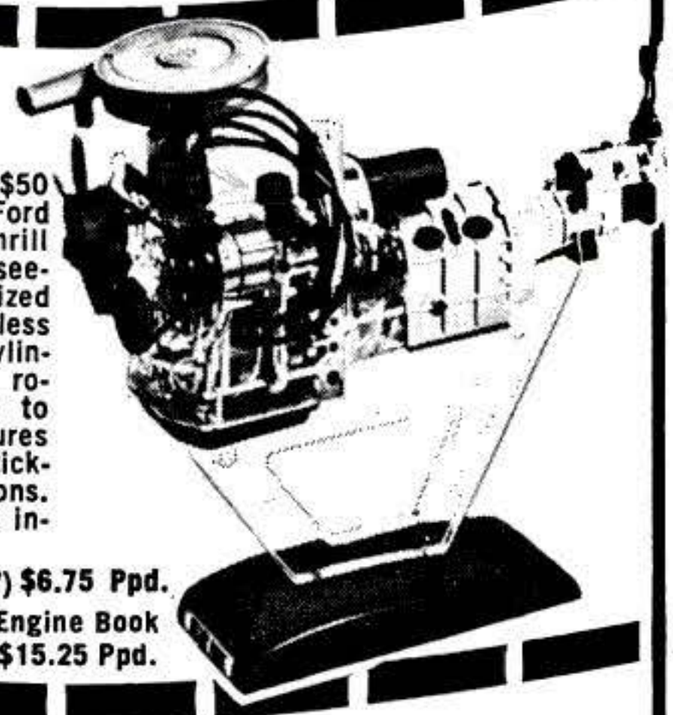

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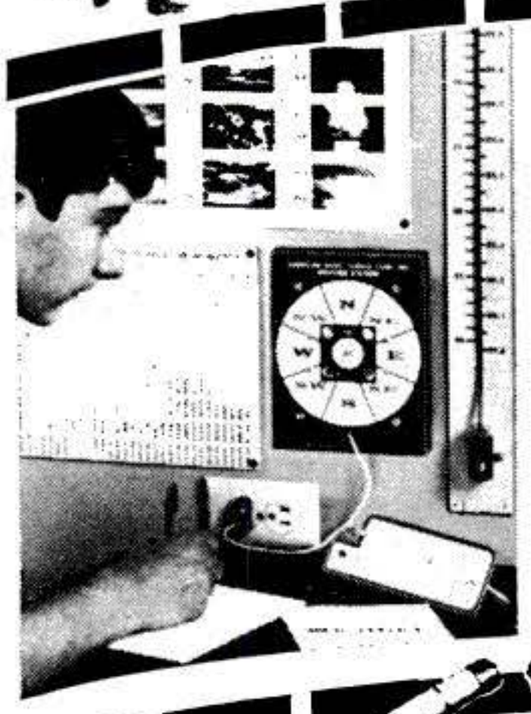

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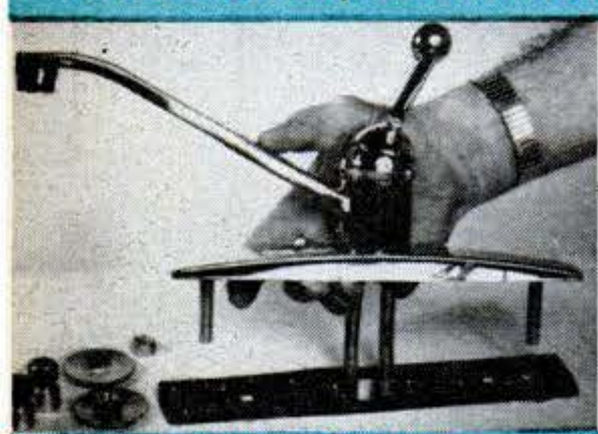

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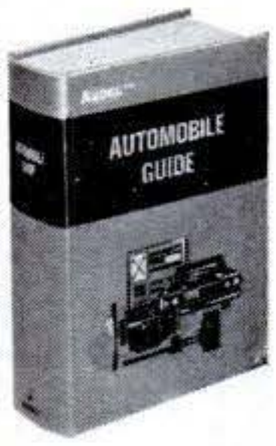

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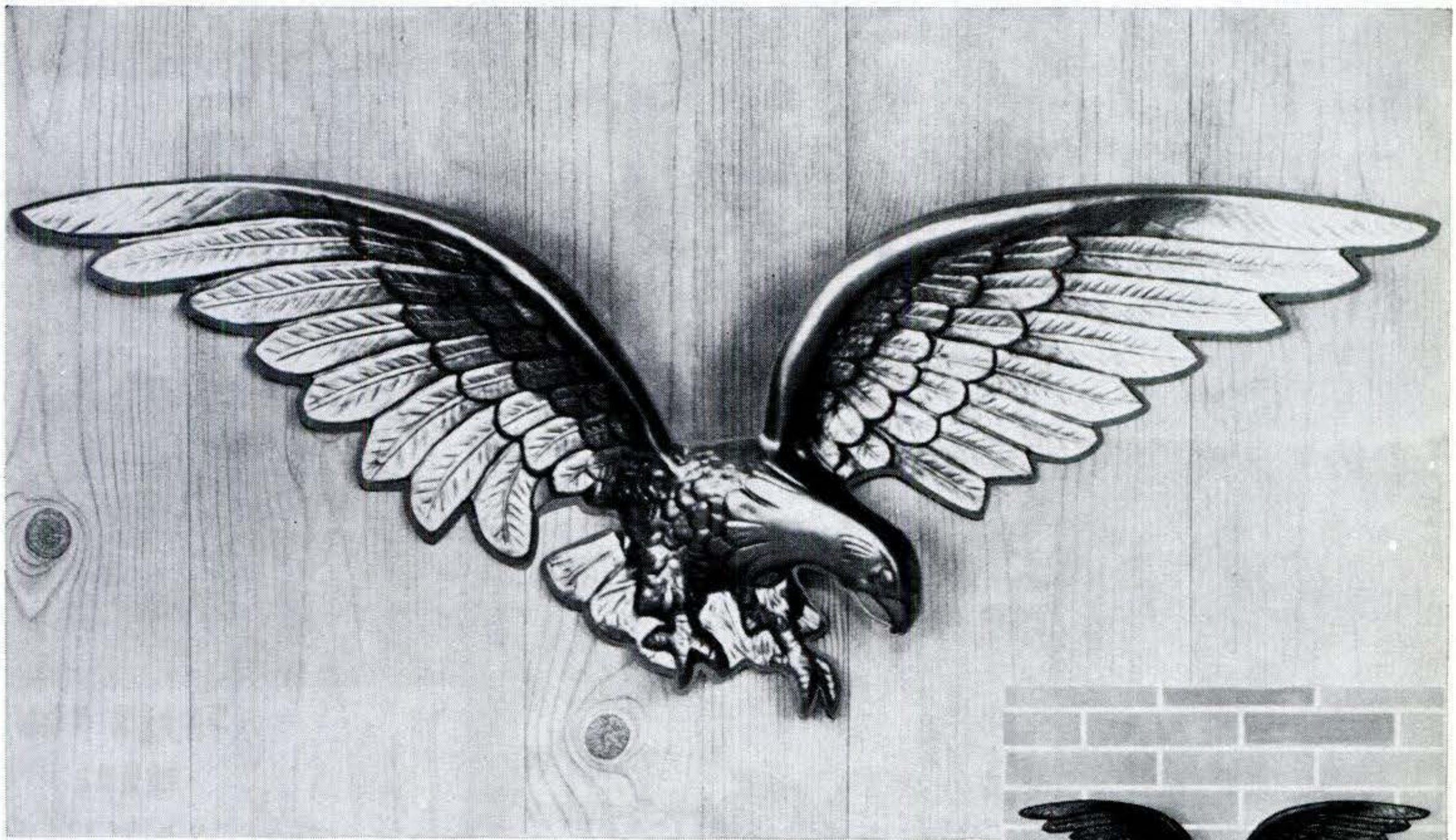

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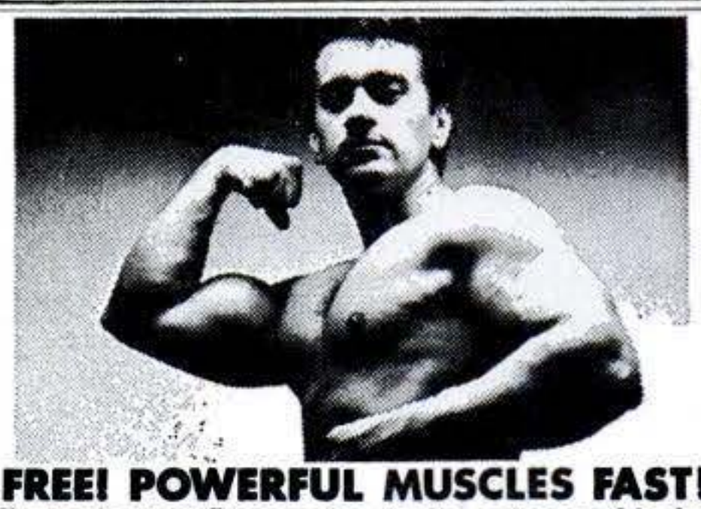

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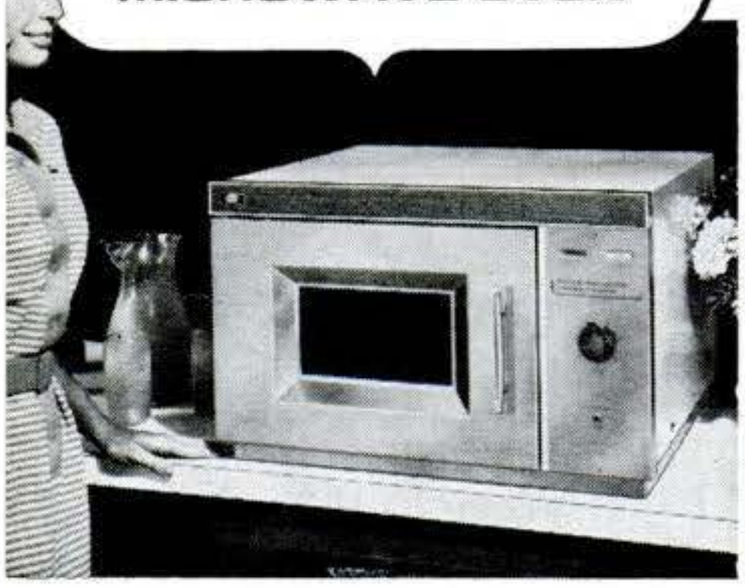

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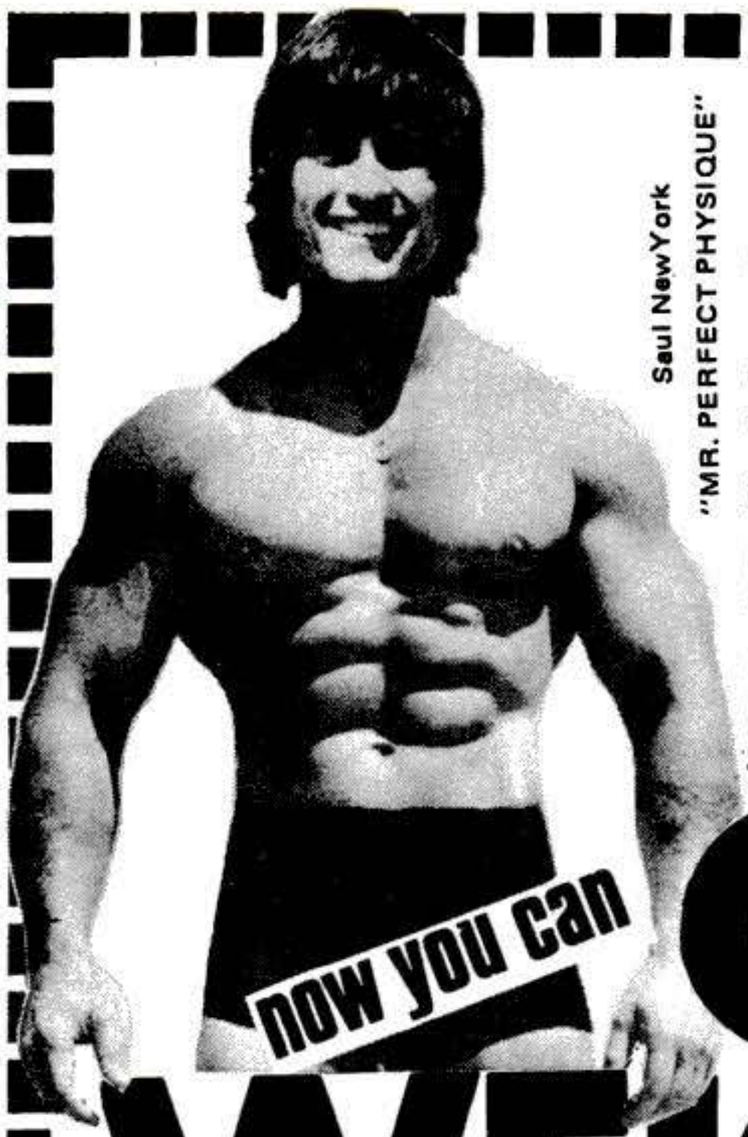

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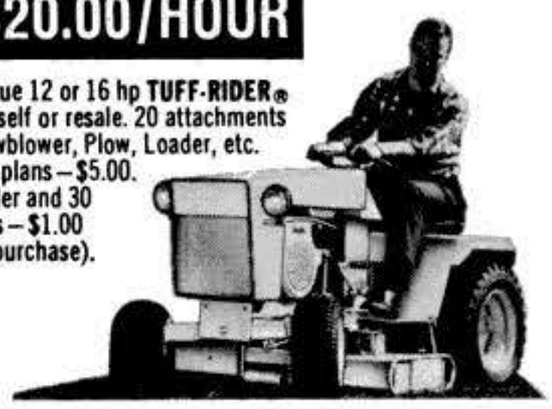

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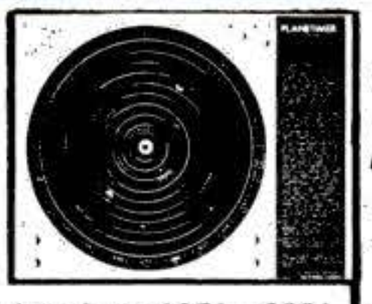

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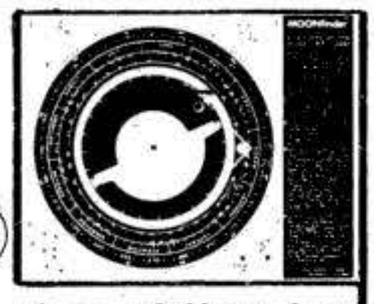

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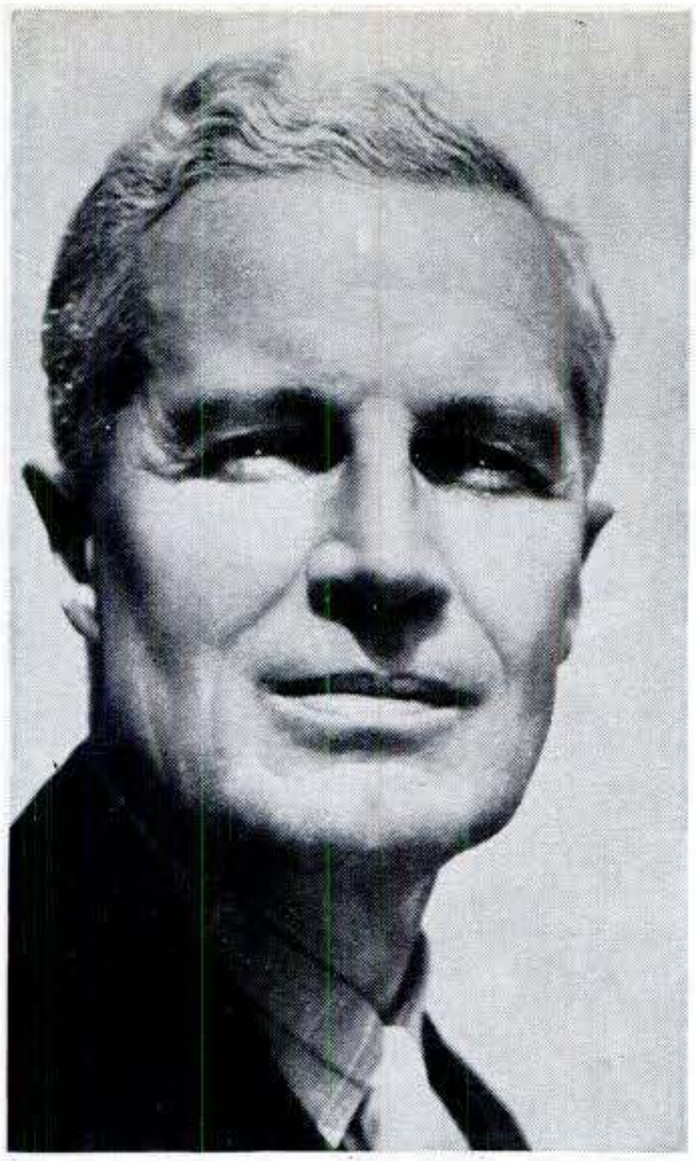

I'd like to give this to my fellow men...

while I am still able to help!

I was young once, as you may be — today I am older. Not too old to enjoy the fruits of my work, but older in the sense of being wiser. And once I was poor, desperately poor. Today almost any man can stretch his income to make ends meet. Today, there are few who hunger for bread and shelter. But in my youth I knew the pinch of poverty; the emptiness of hunger; the cold stare of the creditor who would not take excuses for money. Today, all that is past. And behind my city house, my summer home, my Cadillacs, my winter-long vacations and my sense of independence—behind all the wealth of cash and deep inner satisfaction that I enjoy—there is one simple secret. It is this secret that I would like to impart to you. If you are satisfied with a humdrum life of service to another master, turn this page now—read no more. If you are interested in a fuller life, free from bosses, free from worries, free from fears, read further. This message may be meant for you.

By Victor B. Mason

I am printing my message in a magazine. It may come to the attention of thousands of eyes. But of all those thousands, only a few will have the vision to understand. Many may read; but of a thousand only you may have the intuition, the sensitivity, to understand that what I am writing may be intended for you—may be the tide that shapes your destiny, which, taken at the crest, carries you to levels of independence beyond the dreams of avarice.

Don't misunderstand me. There is no mysticism in this. I am not speaking of occult things, of innumerable laws of nature that will sweep you to success without effort on your part. That sort of talk is *rubbish!* And anyone who tries to tell you that you can *think* your way to riches without effort is a false friend. I am too much of a realist for that. And I hope you are.

I hope you are the kind of man—if you have read this far—who knows that anything worthwhile has to be *earned!* I hope you have learned that there is no reward without effort. If you have learned this, then you may be ready to take the next step in the development of your karma—you may be ready to learn and use the secret I have to impart.

I Have All The Money I Need

In my own life I have gone beyond the need of money. I have it. I have gone beyond the need of gain. I have two businesses that pay me an income well above any amount I have need for. And, in addition, I have the satisfaction—the deep satisfaction—of knowing that I have put more than three hundred other men in businesses of their own. Since I have no need for money, the greatest satisfaction I get from life is sharing my secret of personal independence with others—seeing them achieve the same heights of happiness that have come into my own life.

Please don't misunderstand this statement. I am not a philanthropist. I believe that charity is something that no proud man will accept. I have never seen a man who was worth his salt who would accept something for nothing. I have never met a highly successful man whom the world respected who did not sacrifice something to gain his position. And, unless you are willing to make at least half the effort, I'm not interested in giving you a "leg up" to the achievement of your goal. Frankly, I'm going to charge you something for the secret I give you. Not a lot—but enough to make me believe that you are a little above the fellows who merely "wish" for success and are not willing to sacrifice something to get it.

A Fascinating and Peculiar Business

I have a business that is peculiar—one of my businesses. The unusual thing about it is that it is needed in every little community throughout this country. But it is a business that will never be invaded by the "big fellows." It has to be handled on a local basis. No giant octopus can ever gobble up the whole thing. No big combine is ever going to destroy it. It is essentially a "one man" business that can be operated without outside help. It is a business that is good summer and winter. It is a business that is growing each year. And, it is a business that can be started on an investment so small that it is within the reach of anyone who has a television set. But it has nothing to do with television.

This business has another peculiarity. It can be started at home in spare time. No risk to present job. No risk to present income. And no need to let anyone else know you are "on your own." It can be run as a spare time business for extra money. Or, as it grows to the point where it is paying more than your present salary, it can be expanded into a full time business—overnight. It can give you a sense of personal independence that will free you forever from the fear of lay-off, loss of job, depressions, or economic reverses.

Are You Mechanically Inclined?

While the operation of this business is partly automatic, it won't run itself. If you are to use it as a stepping stone to independence, you must be able to work with your hands, use such tools as hammer and screw driver, and enjoy getting into a pair of blue jeans and rolling up your sleeves. But two hours a day of manual work will keep your "factory" running 24 hours turning out a product that has a steady and ready sale in every community. A half dollar spent for raw materials can bring you six dollars in cash—six times a day.

In this message I'm not going to try to tell you the entire story. There is not enough space on this page. And, I am not going to ask you to spend a penny now to learn the secret. I'll send you all the information, free. If you are interested in becoming independent, in becoming your own boss, in knowing the sweet fruits of success as I know them, send me your name. That's all. Just your name. I won't ask you for a penny. I'll send you all the information about one of the most fascinating businesses you can imagine. With these facts, you will make your own investigation. You will check up on conditions in your neighborhood. You will weigh and analyze the whole proposition. Then, and then only, if you decide to take the next step, I'll allow you to invest $15.00. And even then, if you decide that your fifteen dollars has been badly invested I'll return it to you. Don't hesitate to send your name. I have no salesmen. I will merely write you a long letter and send you complete facts about the business I have found to be so successful. After that, you make the decisions.

Does Happiness Hang on Your Decision?

Don't put this off. It may be a coincidence that you are reading these words right now. Or, it may be a matter that is more deeply connected with your destiny than either of us can say. There is only one thing certain: If you have read this far you are interested in the kind of independence I enjoy. And if that is true, then you must take the next step. No coupon on this advertisement. If you don't think enough of your future happiness and prosperity to write your name on a postcard and mail it to me, forget the whole thing. But if you think there is a destiny that shapes men's lives, send your name now. What I send you may convince you of the truth of this proverb. And what I send you will not cost a penny, now or at any other time.

VICTOR B. MASON

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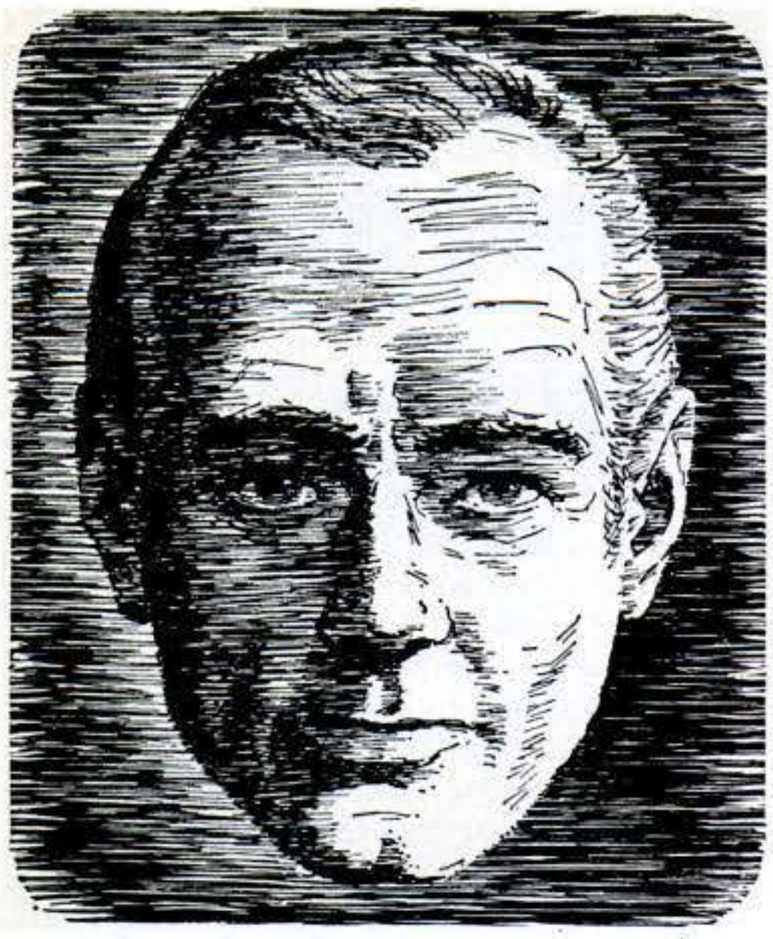
HE HAS INNER VISION



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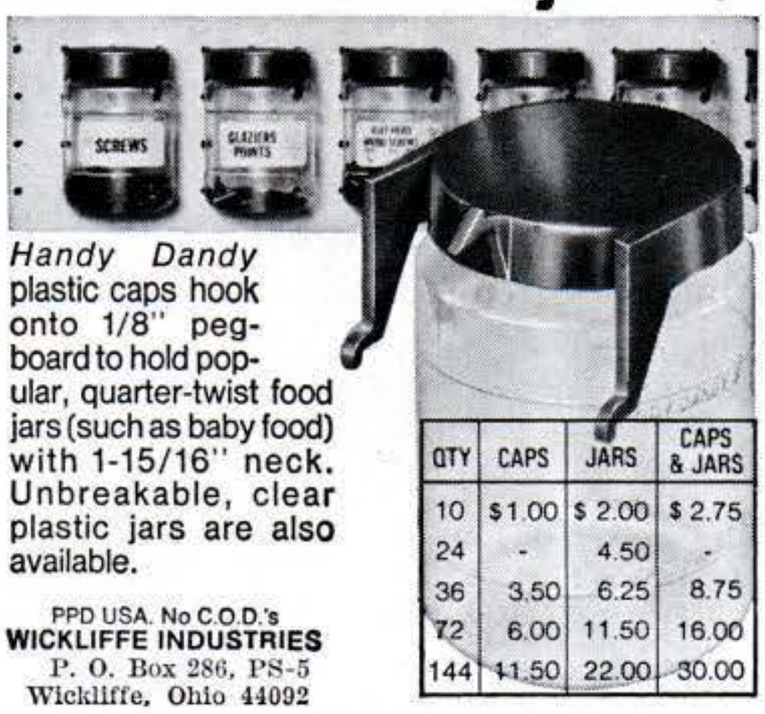

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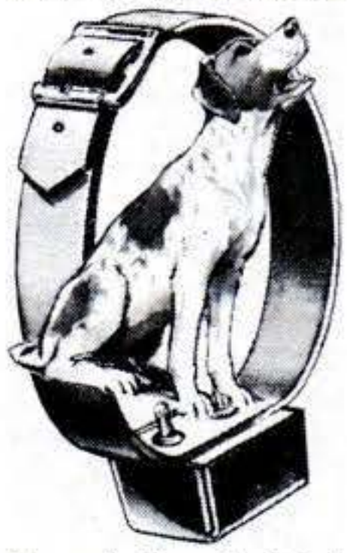
End constant BARK, BARK, BARK!



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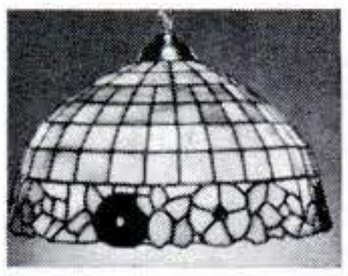

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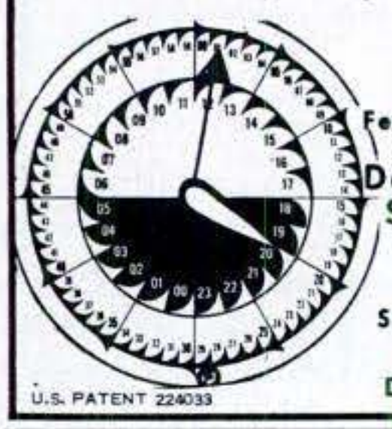

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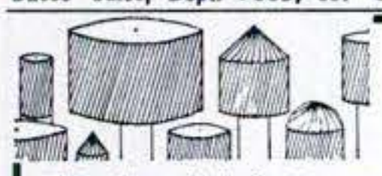

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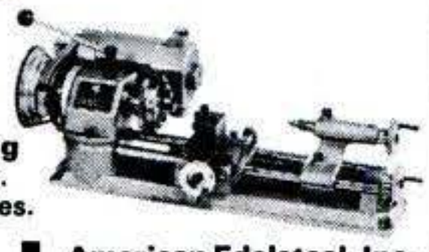

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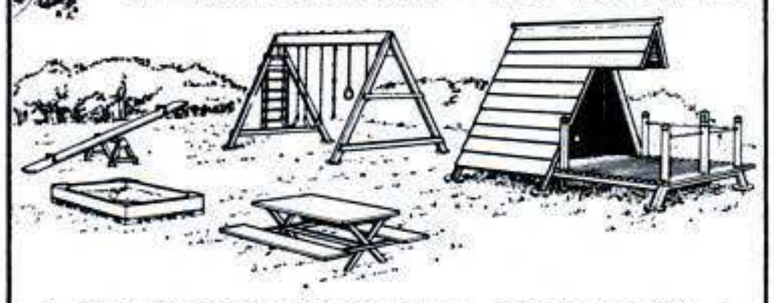

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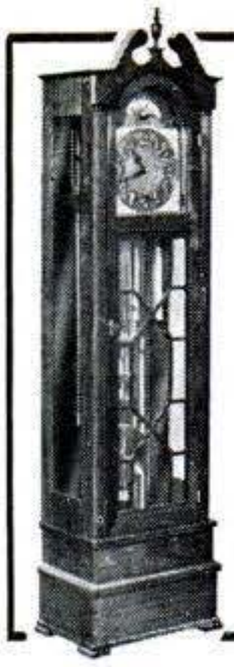

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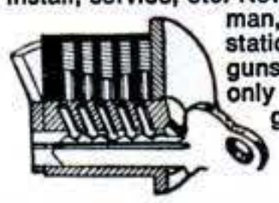

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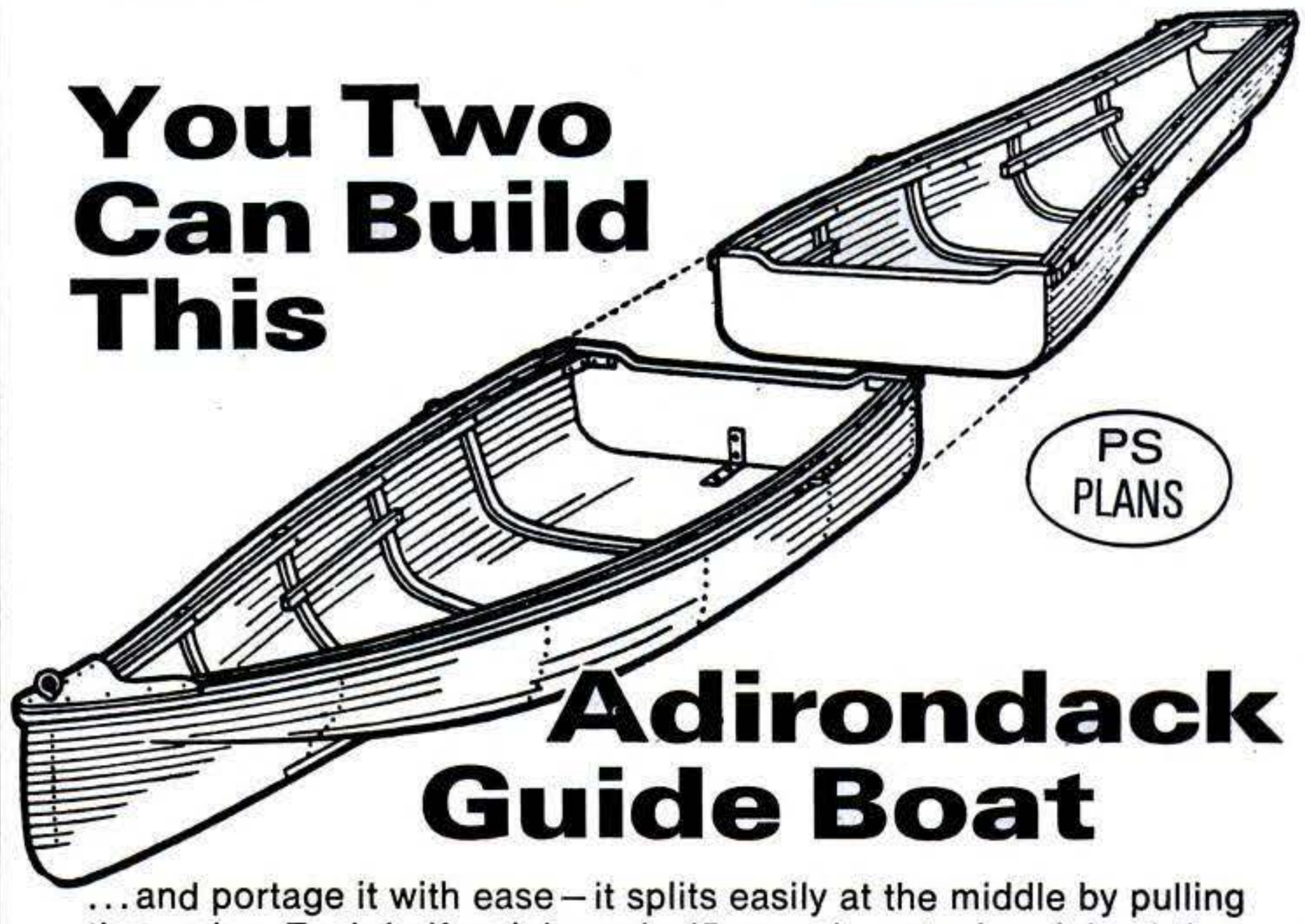

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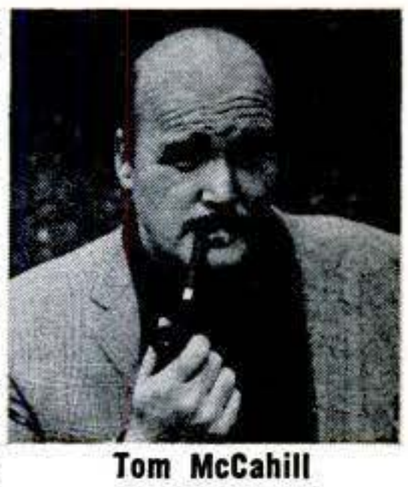

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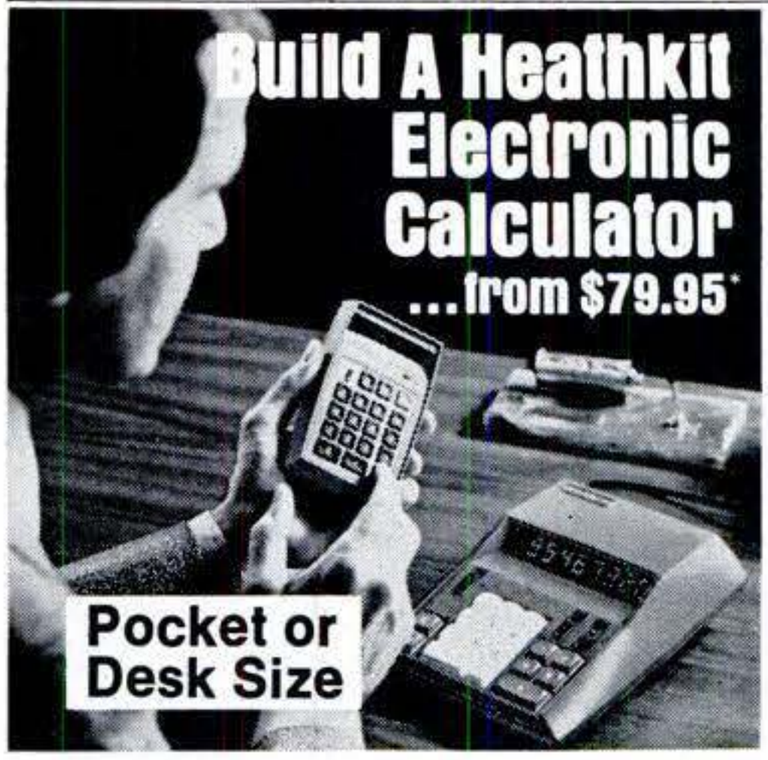

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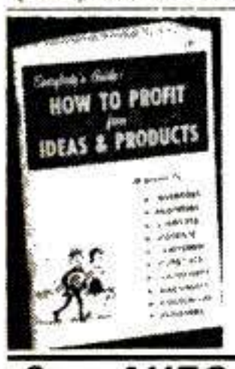

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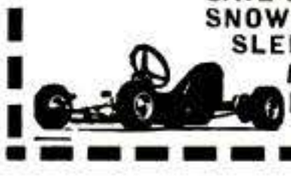

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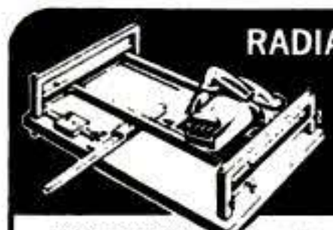

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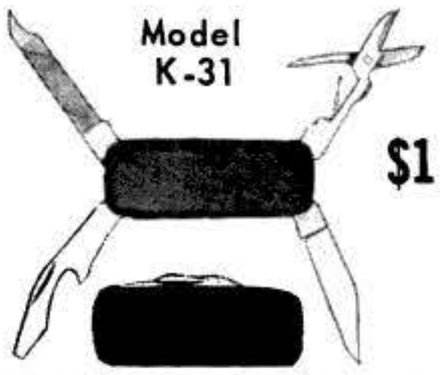

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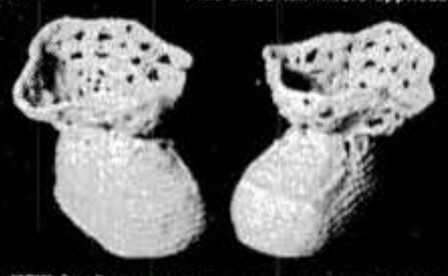

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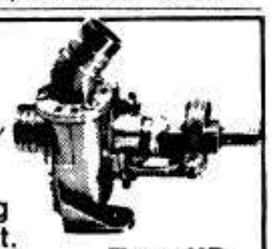

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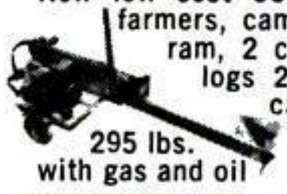

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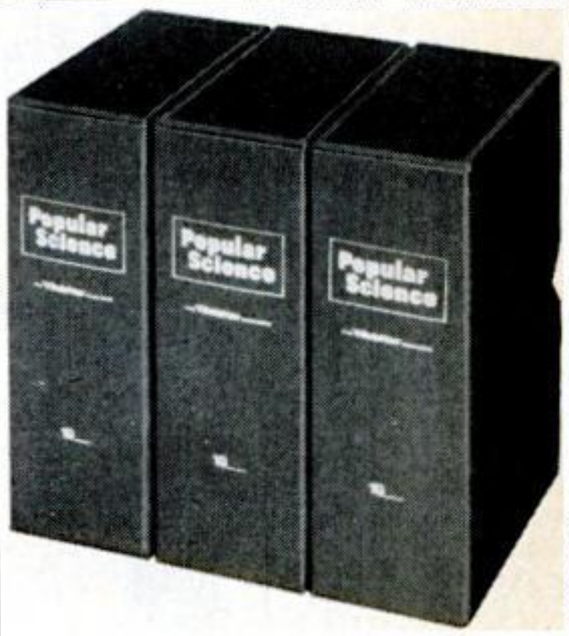

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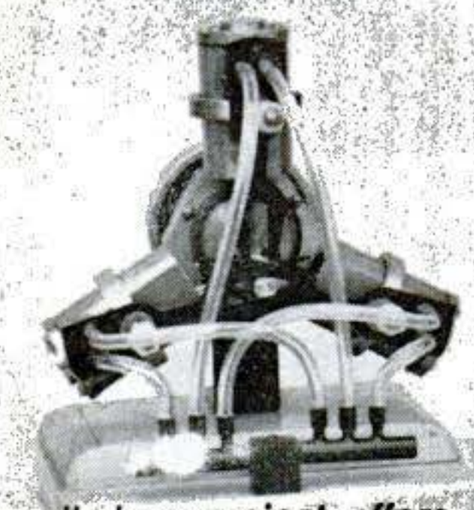

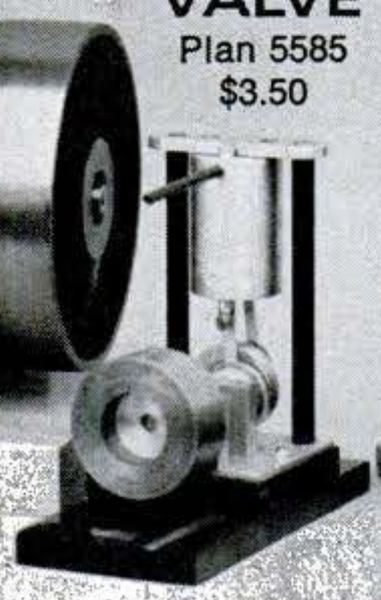

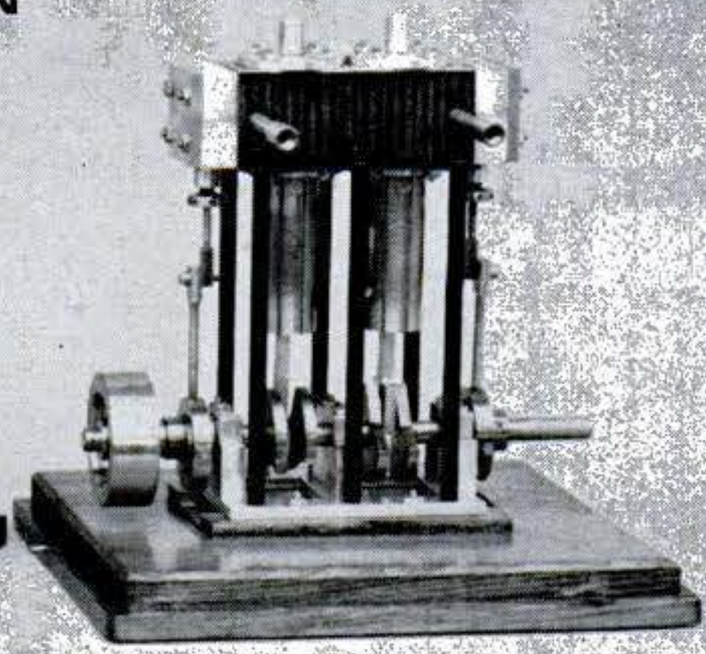

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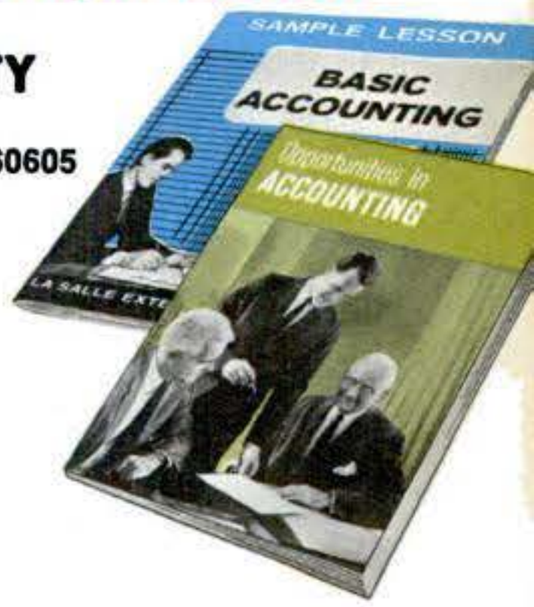

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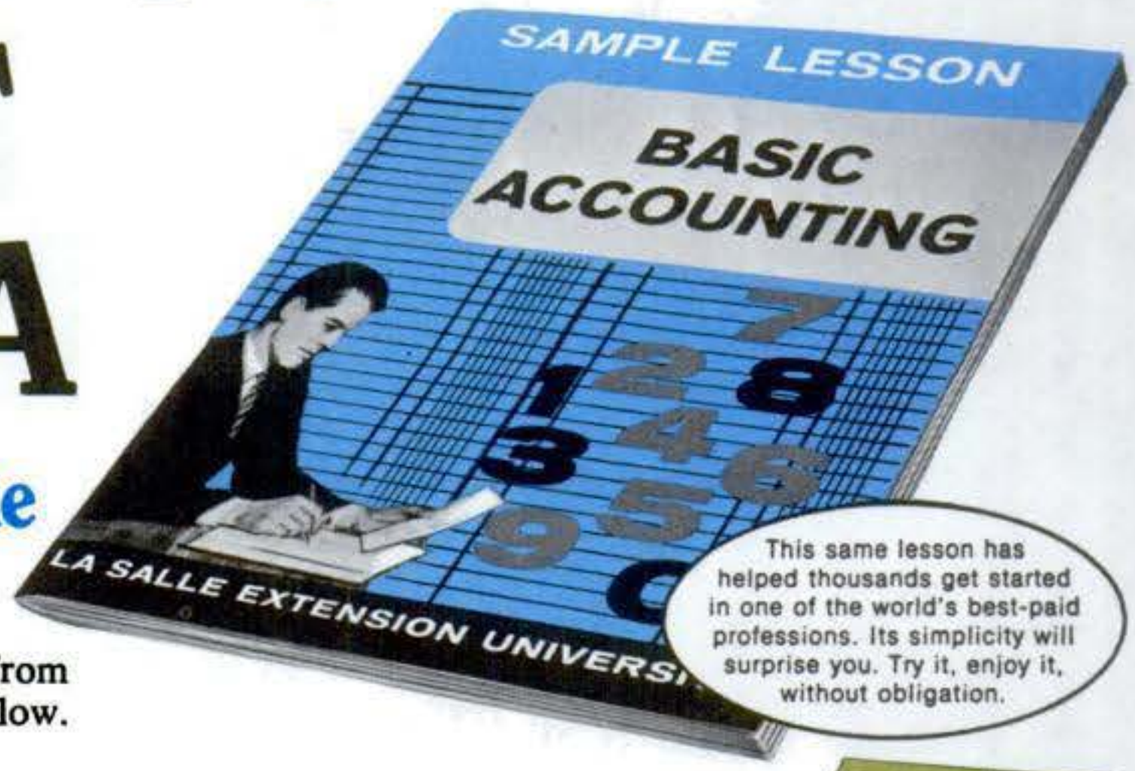

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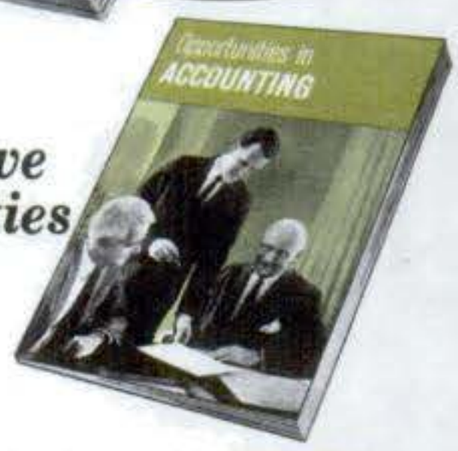

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